GUIDE TO FRUIT PRODUCTION

2012–2013

Publication 360

Ministry of Agriculture,
Food and Rural Affairs

Ontario

Discard old editions of this publication. Each year the appropriate sub-committee of the Ontario Pest Management Research and Services Committee reviews the pesticides listed in this publication. To the best knowledge of the committee, at the time of printing, the pesticide products listed in this publication were:

- federally registered
- classified by the Ministry of the Environment (MOE)

The information in this publication is general information only. The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) does not offer any warranty or guarantee, nor does it assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

This publication lists a number of brand names of pesticides. It is neither an endorsement of the product nor a suggestion that similar products are ineffective.

The Pesticide Label

Consult each product label before you use a pesticide. The label provides specific information on how to use the product safely, hazards, restrictions on use, compatibility with other products, the effect of environmental conditions, etc.

The pesticide product label is a legal document. It is against the law to use the product in any other way.

Federal Registration of Pesticide Products

The Pest Management Regulatory Agency (PMRA) of Health Canada registers pesticide products for use in Canada based on following an evaluation of scientific data to ensure that the product has merit and value, and the human health and environmental risks associated with its proposed use are acceptable.

1. **Full Registration**
   Pesticide registrations are normally granted for a period of five years, subject to renewal.
2. **Conditional Registration**
   Conditional registration may be granted for a specified, limited time period, where the registrant agrees to produce additional scientific or technical information, or the pesticide is used for emergency control of a serious pest outbreak.

Maximum Residue Limits

The PMRA has established maximum residue limits (MRLs) for pesticides. Processors or retailers may demand more restrictive limits. Growers should seek advice of their intended market to determine if more restrictive limitations apply. Keep accurate and up-to-date records on pesticide use in each crop.

Supplemental Labels

You MUST obtain a supplemental label and follow all the label directions when PMRA approves new uses for a registered pesticide that do not appear on the current label.

Examples of when you must use a supplemental label include:

- **Emergency Use Registration**
- **Minor Use Label Expansion**

You can obtain a copy of a supplemental label from the pesticide manufacturer or pesticide vendor, the grower association that sponsored the emergency registration or minor use, from OMAFRA or PMRA's Pest Management Information Service.

For more information on the federal registration status check the PMRA website at *www.pmra-arla.gc.ca* or call 1-800-267-6315.

Regulation of Pesticides in Ontario

The MOE is responsible for regulating pesticide sale, use, transportation, storage and disposal in Ontario. Ontario regulates pesticides by placing appropriate education, licensing and/or permit requirements on their use, under the *Pesticides Act* and Regulation 63/09.

All Pesticides must be used in accordance with requirements under the *Pesticides Act* and Regulation 63/09, which are available on the e-laws website at *www.e-laws.gov.on.ca* or by calling ServiceOntario Publications Toll-Free number: 1-800-668-9938 or 416-326-5300.

Classification of Pesticides

The Ontario Pesticides Advisory Committee (OPAC) is responsible for reviewing and recommending to the MOE, the classification of pesticide products before they can be sold or used in Ontario. Once approved by the MOE, classified products are posted on the MOE website: *www.ene.gov.on.ca*.

Certification and Licensing

Growers and Their Assistants

For information about certification for growers and training for assistants, check the Ontario Pesticide Education Program website: *www.opep.ca* or call 1-800-652-8573.

Commercial Applicators and Their Assistants

For more information about exterminator certification and licensing and technician training, check the Ontario Pesticide Training & Certification website at *www.ontariopesticide.com/OPTC/default.htm* or call 1-888-620-9999 or 519-674-1575.

Cette publication est aussi disponible en français.

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Food and Rural Affairs

Ontario

Need technical or business information?

Contact the Agricultural Information Contact Centre at: 1-877-424-1300 or ag.info.omafra@ontario.ca

Find it on the OMAFRA Website

Technical information for Ontario fruit growers can be easily accessed on the OMAFRA website. Now it's easier than ever to find; just go to the OMAFRA Crops page at:

www.ontario.ca/crops

Click on *Newsletters* for:
- Hort Matters
- Ontario Berry Grower
- Tender Fruit Grape Vine
- Orchard Network
- ON Organic

Click on *Crop Publications* for:
- Publication 360, *Guide to Fruit Production*
- Publication 75, *Guide to Weed Control*
- Supplements to printed publications

Click on *Subscribe to OMAFRA E-mail Notices* if you wish to receive an e-mail notice when new information on fruit and vegetable crops is posted on the OMAFRA website.
- OMAFRA Fruit & Vegetable Crops Notice
- OMAFRA Sound Advice (Audio & Text Updates; Podcast)
- OMAFRA Berry Bulletin
- OMAFRA Tender Fruit & Grape Report
- OMAFRA Vegetable Crop Updates
- OMAFRA Agricultural Business Update

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- Ontario Pest Management Services Committee
- Ontario Pesticide Education Program
- Ontario Soil Management Services Committee

and personnel of:
- Agriculture Development Branch, OMAFRA
- CropLife Canada
- University of Guelph
- Brock University CCOVI
- Ontario Ministry of Environment
- Agriculture and Agri-Food Canada
- several private consulting businesses

Table of Contents

1. Using Pesticides in Ontario

- Federal Registration of Pesticides 1
- Regulation of Pesticides in Ontario 1
  - Classification of pesticides 1
- Certification and Licensing 1
  - Growers and their assistants 1
  - Commercial applicators (exterminators) and their assisting technicians 2
- Pesticide Application Information 2
  - Restricted entry intervals 2
  - Days to harvest for food crops (pre-harvest intervals, pregrazing and feeding intervals) 2
  - Buffer zones 3
- Protect the Environment 3
  - Protect water sources 3
  - Bee poisoning 3
  - Manage drift 4
- Pesticide Disposal 5
  - Empty pesticide containers (up to 23 L) 5
  - Empty pesticide containers (greater than 23 L) 5
  - Surplus spray mix 5
  - Surplus pesticides in storage 5
- Storing Pesticides 5
- Pesticide Spills 6

2. Pest Management

- Integrated Pest Management 7
  - Monitoring and scouting 7
  - Thresholds 8
  - Degree-day modeling and determining a biofix 9
- Pest Management Tools 10
  - Cultural pest controls 10
  - Biological control 11
  - Control with pesticides 12
- Pest Management for Organic Fruit Growers 13
  - Products for organic fruit production 13

3. Soil Management, Fertilizer Use, Crop Nutrition and Cover Crops

- Assessing Nutrient Needs 15
  - Soil testing 15
  - Plant tissue analysis 16
  - Visual deficiency symptoms 18
- Soil Organic Matter 18
- Soil pH and Liming 18
  - Raising pH 19
  - Lowering soil pH 20
- Nitrogen 21
  - Visual nitrogen deficiency symptoms 21
  - Nitrogen and the environment 21
  - Sources of nitrogen 21
- Phosphorus 23
  - Visual phosphorus deficiency symptoms 24
  - Phosphorus in the environment 24
  - Sources of phosphorus 24
  - Phosphorus application methods 24
  - Phosphorus recommendations 25
- Potassium 25
  - Visual potassium deficiency symptoms 25
  - Sources of potassium 25
  - Potassium application methods 25
  - Potassium recommendations 25
- Calcium 26
- Magnesium 26
- Micronutrients 26
  - Which to choose: soil or foliar fertilizers? 28
  - Boron 28
  - Copper 28
  - Iron 28
  - Manganese 29
  - Zinc 29
- Cover Crops 29
  - Grasses 29
  - Legumes 30
  - Non-legume broadleaves 30
  - New and emerging cover crops 30

4. Apples

- Apple Nutrition 33
- Manure for Orchards 33
- pH Requirements 33
- Leaf Analysis 33
- Fertilizer for Apples 34
  - Fertilizer for non-bearing apples 34
  - Fertilizer for bearing apples 34
- Micronutrients for Apples 38
- Apple Calendar 40
- Guidelines for Protecting Non-Bearing Apple Plantings 55
- Notes on Apple Insects 59
- Notes on Apple Diseases 64
  - Apple scab 64
  - Management of apple scab with fungicides 66
  - Fungicide resistance 68
- Thinning and Plant Growth Regulators 69
  - Chemical thinning of apples 69
  - Fruit size distribution in the tree canopy 69
  - Steps in thinning 70
  - Chemicals available for thinning 70
  - Factors influencing response to thinning agents 74
  - Timing of application 75
  - Cultivar notes 75
  - Suggested rates for chemical thinning of apples 77
  - Special conditions 77
  - Key concepts and benefits of hand thinning 78
- Plant Growth Regulators 78
  - Promalin or Perlan to improve fruit shape of Delicious 78
  - Ethephon to enhance bloom on non-bearing trees 79
  - Ethephon to promote fruit colouring 79
  - Chemical control of preharvest drop of apples 79
  - Products to control preharvest drop 80
  - Vegetative growth control in apples 81

5. Berry Crops

- Berry Crop Nutrition 85
- Blueberries, Highbush 85
  - pH requirements 85
  - Fertilizer for blueberries 85
  - Leaf analysis 86
- Currants and Gooseberries 86
  - pH requirements 87
  - Fertilizer before planting 87
  - Fertilizer in established plantings 87
- Raspberries 87
  - pH requirements 87
  - Fertilizer for raspberries 88
  - Leaf analysis 88
- Strawberries 88
  - pH requirements 88

Fertilizer for new plantings (the planting year) 89
Fertilizer for established plantings 89
Leaf analysis 90
Micronutrients for Berry Crops 90
Blueberry Calendar 92
Notes on Blueberry Diseases and Insects 99
Currant and Gooseberry Calendar 101
Elderberries 104
Summer-fruiting Raspberry Calendar 105
Fall-bearing Raspberry Calendar (primocane fruiting) 109
Notes on raspberry diseases and insects 113
Saskatoon Berry Calendar 115
Sea Buckthorn 118
Non-bearing Strawberry Calendar (planting year) 119
June-bearing Strawberry Calendar (fruiting years) 121
Day-neutral Strawberry Calendar 126
Notes on strawberry diseases and insects 132

6. Grapes

Grape Nutrition 137
Manure for Vineyards 137
pH Requirements 137
Petiole Analysis 137
Fertilizer for Grapes 138
Micronutrients 139
Grape Calendar 141
Notes on grape pests 158

7. Tender Fruit

Tender Fruit Nutrition 161
Manure for Orchards 161
pH Requirements 161
Leaf Analysis 161
Fertilizer for Tender Fruit 162
Fertilizer for non-bearing tender fruit 162
Fertilizer for bearing tender fruit trees 162
Micronutrients for Tender Fruit 164
Apricot Calendar 166
Sour Cherry Calendar 172
Growth Regulators for Sour Cherries 178
Ethephon (Ethrel) to promote fruit loosening of sour cherries at harvest 178
Gibberellic acid 178
Sweet Cherry Calendar 179
Growth Regulators for Sweet Cherries 183
To delay ripening and improve fruit quality of sweet cherries 183
Peach Calendar 185
Thinning Peaches 194
Factors to consider when thinning peaches 194
Pear Calendar 196
Thinning Pears 206
Plum Calendar 208
Notes on Plums 212
Heat spot 212
Thinning Plums 212
Notes on Fungicides for Tender Fruit 214

8. Tree Nuts

Walnut Calendar 217
Pecan and Sweet Chestnut Calendar 219
Filbert/Hazelnut Calendar 220

9. Other Pests and Disorders

Nematodes 223
Thresholds 223
Nematode management 224
Deer Control 226
Deer removal permit program 226
Mouse and Vole Control in Orchards 226
Bait for mouse and vole control in orchards 226
Controlling Rabbits 227
Wrapping young trees 227
Repellents 227
Repairing damage by mice and rabbits 227
Bird Control 228
Controlling bird damage 228
Control of Southwest Injury on Fruit Trees 229
Preventing Heat Stress and Fruit Sunburn on Apple and Pear Trees 229

10. Pesticide Application

Handling and Mixing Pesticides 231
Formulations 231
Soluble packaging 231
Mixing soluble pouches 231
Compatibility of spray materials 231
Jar test for testing compatibility of pesticide mixtures 232
Filling and Agitation 233
Tank water 233
Agitation 233
Filling the tank 233
Calculating Water Volume and Pesticide Rates 234
Carrier volume 234
Dose rate 234
Crop-adapted spraying and application rates 234
Sprayer Calibration and Nozzle Maintenance 235
Calculating travel speed 235
Nozzle maintenance 235
Calculating Output 236
Timed output of the average nozzle 236
Horizontal boom sprayer – total output 236
Horizontal boom sprayer – band spraying output 236
Airblast sprayer output in an orchard or vineyard 236
New Developments in Spraying Technology 238
Single-piece moulded nozzle tips 238
Air-induction nozzles on airblast sprayers 238
Other Resources 238

11. Reduced-risk Pesticides and Biopesticides

Reduced-risk Pesticides and Biopesticides 241
Reduced-risk products 241
Biopesticides 241
Biopesticides for Disease Control 242
Streptomyces lydicus (Actinovate) 242
Bacillus subtilis (Serenade ASO, Serenade MAX) 242
Potassium bicarbonate (MilStop Foliar Fungicide) 243
Pantoea agglomerans (Bloomtime Biological FD) 243
Pseudomonas syringae (Bio-Save 10 LP) 243
Biopesticides for Insect Control 247
Kaolin Clay (Surround WP) 247
Bacillus thuringiensis var. *kurstaki* (Bioprotec CAF, Bioprotec 3P, Dipel 2X DF, Dipel WP, Foray 48BA) 247
Insecticidal soaps – potassium salts of fatty acids (Opal Insecticidal Soap, Safer's Insecticidal Soap) 247
Cydia pomonella granulosis virus (Virosoft CP-4 , CYD-X) 248
Using Mating Disruption in Fruit Crops 248
Using mating disruption to control oriental fruit moth (Isomate-M Rosso and Isomate-M 100) 249
Using mating disruption to control codling moth and oriental fruit moth with the twin tube (Isomate-CM/OFM TT) 249
Using mating disruption to control grape berry moth (Isomate-GBM Plus) 250
Other Reduced-risk Products with Special Considerations 251
GF-120 NF Naturalyte Fruit Fly Bait 251
Mineral oil (Purespray Green Spray Oil 13E) 252

12. Managing Pest Resistance

Pest Resistance to Insecticides, Fungicides, Miticides 253
Assessing resistance risk 253
Resistance Management Strategies 253
General resistance management strategies 253
Managing resistance to fungicides 254
Managing resistance to insecticides and miticides 255

13. Information on Pesticides

Relative Acute Toxicity of Pesticides 261
Re-entry Interval 261
Bee Poisoning 267
Use of Copper Products on Fruit Crops 269
  Chemical characteristics of copper fungicides 269
  Procedures to tank-mix copper formulations and lime 269
  Registration status and availability of copper fungicide products 269
Pesticides Used on Fruit Crops in Ontario 272
Pesticide Classification in Ontario 285

14. Appendices

Appendix A: Suppliers of Pest Monitoring Equipment and Biological Control Agents 287
APPENDIX B: Safety Supply Companies 288
Appendix C: Accredited Soil-Testing Laboratories in Ontario 289
APPENDIX D: Diagnostic Services 290
APPENDIX E: Ontario Ministry of Agriculture, Food & Rural Affairs Fruit Crop Advisory Staff 293
APPENDIX F: Ontario Ministry of the Environment – Regional Contact Information 294
APPENDIX G: Other Contacts 295
APPENDIX H: Production Insurance 296
Appendix I: The Metric System 297
Spraying Record 300

List of Tables

1. Using Pesticides in Ontario

Table 1-1. Requirements for Pesticide Storage Facilities 6

2. Pest Management

Table 2-1. Examples of Traps Used for Monitoring Fruit Pests 8
Table 2-2. Examples of Thresholds Used for Fruit Pests in Ontario 9
Table 2-3. Examples of Degree-Day Models Used in Fruit Crops 10
Table 2-4. Examples of Classical Biological Control in Ontario Fruit Crops 11
Table 2-5. Examples of Augmenting Natural Enemies from Commercial Sources 12
Table 2-6. Efficacy Ratings for Insecticides, Miticides and Fungicides 13
Table 2-7. Products for Organic Fruit Production 14

3. Soil Management, Fertilizer Use, Crop Nutrition and Cover Crops

Table 3-1. OMAFRA-Accredited Soil Tests 15
Table 3-2. Soil Test Nutrient Ratings 16
Table 3-3. Sampling for Tissue Analysis of Fruit Crops 17
Table 3-4. Nutrient Concentration Sufficiency Ranges for Fruit Crops 18
Table 3-5. Optimum Soil Organic Matter Contents for a Range of Soil Types 18
Table 3-6. Soil pH at which Lime is Recommended for Ontario Field-Grown Crops 19
Table 3-7. Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH 19
Table 3-8. Calculation of Lime Required Using Buffer pH and Target pH 20
Table 3-9. Sulphur for Soil Acidification (kg/ha) 21
Table 3-10. Fertilizer Materials: Primary Nutrients 21
Table 3-11. Average Fertilizer Replacement Values for Different Types of Manure 22
Table 3-12. Nitrogen Contribution of Plowed Down Legumes 23
Table 3-13. Phosphorus Requirements for Berries, Tree Fruits and Grapes 24
Table 3-14. Potassium Requirements for Berries, Tree Fruits and Grapes 25
Table 3-15. Application Rates for Magnesium, Calcium and Micronutrients 27
Table 3-16. Magnesium Soil Test Ratings and Interpretation for All Fruit Crops 27
Table 3–17. Selecting a Cover Crop 30
Table 3-18. Characteristics of Cover Crops 31

4. Apples

Table 4-1. Foliar Nutrient Sufficiency Range of Apple (Mid-Shoot Leaves Taken in Last Two Weeks of July from Mature Trees) 33
Table 4-2. Phosphorus and Potassium Soil Requirements Before Planting Apples 34
Table 4-3. Approximate Grams of Actual Nitrogen Required per Tree at Various Tree Densities and Tree Ages, Growing in Sod 35
Table 4-4. Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod 36
Table 4-5. Calcium Foliar Sprays 37
Table 4-6. Magnesium Foliar Sprays 38
Table 4-7. Products Used on Apples 57
Table 4-8. Activity of Petal Fall Insecticides Against Orchard Pests 59
Table 4-9. Activity of Miticides Registered on Apple and/or Pear in Ontario 60
Table 4-10. Activity of Insecticides and Miticides on Apple Pests 60
Table 4-11. Toxicity of Pesticides to Mite and Aphid Predators 63
Table 4-12. Relationship of Temperature and Moisture to Apple Scab Infection 65
Table 4-13. Characteristics of Apple Scab Fungicides 67
Table 4-14. Activity of Fungicides on Apple Diseases 68
Table 4-15. Effect of Apple Fruit Size on Tray and Bin Requirements 69
Table 4-16. Effect of Fruit Size in Relation to Crop Load 70
Table 4-17. Suggested Rates of MaxCel or Cilis Plus to Use With or Without Sevin 71
Table 4-18. The Relationship Between Spray Water Volumes, Grams Active Ingredient (6-BA) per Hectare, Litres of Product per Hectare and Final Tank Concentration of MaxCel or Cilis Plus 71
Table 4-19. Suggested Rates for Chemical Thinning of Mature Apple Trees 73
Table 4-20. Optimum Fruitlet Size for Chemical Thinning 75
Table 4-21. Suggested Apogee Rates and Timings Based on a Tree-Row Volume Dilute of 1,000 L/ha 82

5. Berry Crops

Table 5-1. Amount of Sulphur Required to Lower Soil pH (kg/ha) 85
Table 5-2. Nitrogen Requirements for Highbush Blueberries 85
Table 5-3. Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries 86

Table 5-4. Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves ... 86
Table 5-5. Recommended Nitrogen Rates for Raspberries ... 88
Table 5-6. Ranges for Nutrient Levels in Raspberry Leaves ... 88
Table 5-7. Recommended Nitrogen (N) Rates for Strawberries ... 90
Table 5-8. Optimum Nutrient Level Range of Strawberry Leaves ... 90
Table 5-9. Products Used on Blueberries ... 97
Table 5-10. Activity of Fungicides on Blueberry Diseases ... 99
Table 5-11. Activity of Insecticides on Blueberry Pests and Bees ... 100
Table 5-12. Products Used on Currants ... 103
Table 5-13. Disease Ratings on Selected Currant and Gooseberry Varieties ... 103
Table 5-14. Pest Management Products for Elderberries ... 104
Table 5-15. Products Used on Raspberries ... 111
Table 5-16. Activity of Fungicides on Raspberry Diseases ... 113
Table 5-17. Activity of Insecticides on Raspberry Pests and Bees ... 114
Table 5-18. Products Used on Saskatoon Berries ... 117
Table 5-19. Pest Management Products for Sea Buckthorn ... 118
Table 5-20. Products Used on Strawberries ... 130
Table 5-21. Activity of Fungicides on Strawberry Diseases ... 132
Table 5-22. Miticides Registered on Strawberries ... 133
Table 5-23. Activity of Insecticides on Strawberry Pests and Bees ... 134
Table 5-24. Strawberry Variety Disease Ratings ... 135

6. Grapes

Table 6-1. Nutrient Sufficiency Range of Grape Petioles (Taken in September from Mature Vines) ... 138
Table 6-2. Phosphorus and Potassium Soil Requirements for New Plantings of Grapes ... 138
Table 6-3. Magnesium Foliar Sprays ... 139
Table 6-4. Products Used on Grapes ... 156
Table 6-5. Relative Susceptibility of Grape Cultivars to Diseases ... 158
Table 6-6. Activity of Fungicides on Grape Diseases ... 159
Table 6-7. Activity of Insecticides on Grape Insect Pests ... 160

7. Tender Fruit

Table 7-1. Nutrient Concentration Sufficiency Ranges for Tender Fruits (Mid-shoot Leaves in Late July) ... 162
Table 7-2. Phosphorus and Potassium Soil Requirements Before Planting Tender Fruit Trees ... 162
Table 7-3. Actual Nitrogen Rates per Tree in Sod Culture ... 163
Table 7-4. Magnesium Foliar Sprays ... 165
Table 7-5. Products Used on Apricots ... 170
Table 7-6. Products Used on Sour Cherries ... 176
Table 7-7. Products Used on Sweet Cherries ... 182
Table 7-8. Products Used on Peaches ... 192
Table 7-9. Products Used on Pears ... 204
Table 7-10. Products Used on Plums ... 213
Table 7-11. Activity of Fungicides on Tender Fruit Diseases ... 214
Table 7-12. Activity of Insecticides and Miticides on Tender Fruit Pests ... 215

8. Tree Nuts

Table 8-1. Products Used on Tree Nuts ... 222

9. Other Pests and Disorders

Table 9-1. Thresholds for Nematodes on Fruit Crops ... 223
Table 9-2. Control of Nematodes and Other Soil-borne Pests Before Planting Fruit Crops ... 225
Table 9-3. Bait for Mouse and Vole Control ... 227

11. Reduced-risk Pesticides and Biopesticides

Table 11-1. Examples of Reduced-risk Pesticides Used for Fruit Crops in Ontario ... 241
Table 11-2. Characteristics of Biopesticides Registered on Fruit Crops ... 244

12. Managing Pest Resistance

Table 12-1. Factors Favouring the Development of Resistance ... 253
Table 12-2. Fungicide/Bactericide Groups Based on Sites of Action ... 257
Table 12-3. Insecticide and Miticide Groups Based on Sites of Action ... 258

13. Information on Pesticides

Table 13-1. Relative Acute Toxicity of Pesticides and Plant Growth Regulators ... 262
Table 13-2. Re-entry Intervals for Pesticides and Plant Growth Regulators ... 263
Table 13-3. Relative Toxicity of Pesticides to Honeybees ... 268
Table 13-4. Copper Products Available for Use on Fruit Crops in Ontario ... 270
Table 13-5. Pesticides Used on Fruit Crops in Ontario ... 272
Table 13-6. Thinners and Plant Growth Regulators Used on Fruit Crops in Ontario ... 284
Table 13-7. Pesticide Classification Schedules In Ontario: Classes 2, 3, and 4 ... 285
Table 13-8. Pest Control Product Companies ... 286

List of Figures

4. Apples

Figure 4-1. Apple Growth Stages ... 39
Figure 4-2. Cumulative Percentage of Ascospores Matured at Various Degree-day Accumulations ... 65
Figure 4-3. Comparison of Thinning Effects on Fruit Size Distribution in the Tree Canopy ... 69
Figure 4-4. Anatomy of an Apple Bloom ... 78
Figure 4-5. Diagram Indicating Bourse Shoot Development ... 82

5. Berry Crops

Figure 5-1. Blueberry Growth Stages ... 91

6. Grapes

Figure 6-1. Grape Growth Stages ... 140

7. Tender Fruit

Figure 7-1. Apricot Growth Stages ... 165
Figure 7-2. Sour and Sweet Cherry Growth Stages ... 171
Figure 7-3. Peach Growth Stages ... 184
Figure 7-4. Pear Growth Stages ... 195
Figure 7-5. Plum and Prune Growth Stages ... 207

10. Pesticide Application

Figure 10-1. Water-sensitive Papers Showing a Range of Spray Coverage ... 234
Figure 10-2. Distribution of Airblast Output for a Classic Spindle Apple Orchard ... 237
Figure 10-3. Distribution of Airblast Output with Towers for a Classic Spindle Apple Orchard ... 237

1. Using Pesticides in Ontario

The information in this chapter is updated regularly. For up-to-date information, visit the OMAFRA website at *www.ontario.ca/usingpesticides*.

Read the latest product label before using a pesticide! Review the Grower Pesticide Safety Course Manual. Keep detailed spray records.

Federal Registration of Pesticides

Before a pesticide can be sold or used in Ontario, it must be registered under the federal *Pest Control Products Act* (PCP Act) and be classified under the provincial *Pesticides Act*. The Pest Management Regulatory Agency (PMRA) of Health Canada registers pesticides for use in Canada following an evaluation of scientific data to ensure that the product has merit and value. It also ensures that the human health and environmental risks associated with its proposed use are acceptable.

The PMRA re-evaluates registered pesticides to determine whether today's health and environmental protection standards are still met when following the label directions. Outcomes of a re-evaluation can be:

- no change in the registration
- label amendments (i.e., changes to personal protective equipment requirements, restricted entry intervals and buffer zones)
- modifications to existing maximum residue limits (MRLs)
- elimination or phasing-out of certain uses or formulations
- no further acceptance of the registration

The pesticide label is a legal document. It prescribes how the pesticide can be legally used. Off-label use is prohibited. It is against the law to use the pesticide in any other way or on any other crop or pest than as specified on the label. Labels for all registered pesticides are under Search Pesticide Labels on the PMRA website at *www.pmra-arla.gc.ca*. Ensure you have the most current label and are aware of any re-evaluation decisions.

Regulation of Pesticides in Ontario

The Ministry of the Environment (MOE) is responsible for regulating the sale, use, transportation, storage and disposal of pesticides in Ontario. Ontario regulates pesticides by placing appropriate education, licensing and/or permit requirements on their use, under the *Pesticides Act* and Regulation 63/09. All pesticides must be used in accordance with requirements under the *Pesticides Act* and Regulation 63/09, which are available on the e-laws website at *www.e-laws.gov.on.ca* or by calling Service Ontario at 1-800-668-9938 or 416-326-5300.

Classification of pesticides

Before a federally registered pesticide can be sold or used in Ontario, it must be classified under the provincial *Pesticides Act*. The Ontario pesticide classification system consists of 11 classes. The Ontario Pesticides Advisory Committee (OPAC) is responsible for reviewing and recommending to the MOE the classification of pesticide products. Pesticide products are classified on the basis of their toxicity, environmental or health hazard, persistence of the active ingredient or its metabolites, concentration, usage, federal class and registration status. This classification system provides the basis for regulating the distribution, availability and use of pesticide products in Ontario. Once approved by the MOE, classified products are posted on the MOE website at *www.ontario.ca/environment*. Ontario pesticide classification for products used on fruit crops is listed in Table 13-5. *Pesticides Used on Fruit Crops in Ontario*, page 272.

Certification and Licensing

Growers and their assistants

Growers must be certified through the Grower Pesticide Safety Course in order to buy and use Class 2 and 3 pesticides on their farms. They do not require this certification to use Class 4, 5, 6 or 7 pesticides. For information about certification for growers and training for assistants to growers, visit the Ontario Pesticide Education Program website at *www.opep.ca* or call 1-800-652-8573.

Commercial applicators (exterminators) and their assisting technicians

For more information about exterminator licensing and technician training, visit the Ontario Pesticide Training and Certification website at *www.ontariopesticide.com/index.cfm/home-page* or call 1-888-620-9999 or 519-674-1575.

For more information about pesticide regulations, certification and licensing, see:

- Inside front cover of this publication
- Pest Management Regulatory Agency (PMRA) website: *www.pmra-arla.gc.ca*
- PMRA Pest Management Information Service: 1-800-267-6315 (from within Canada) or 1-613-736-3799 (from outside Canada)
- Ontario Ministry of the Environment (MOE) website: *www.ontario.ca/environment*
- Regional MOE Pesticides Specialist (See Appendix F. *Ontario Ministry of the Environment Regional Contact Information*, page 294)
- Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) website: *www.ontario.ca/omafra*
- Ontario Pesticide Education Program (University of Guelph, Ridgetown Campus) website: *www.opep.ca*
- Ontario Pesticide Training & Certification website: *www.ontariopesticide.com/index.cfm/home-page*

Pesticide Application Information

When you decide to use a pesticide, choose the most appropriate formulation and application method for your situation. Use only a properly calibrated sprayer. Choose less toxic alternatives when possible. Take all possible precautions to prevent the exposure of people and non-target organisms to the pesticide. Read the most current pesticide label thoroughly before application. The label provides important information, such as:

- directions for use (rates of application, crops it can be used on, target pests, crop rotation restrictions, total number of applications, droplet size/nozzle type, application equipment, timing and ideal weather conditions)
- required personal protective equipment (PPE)
- hazard symbols and warnings
- restricted entry intervals
- buffer zones
- precautionary statements
- steps to be taken in case of an accident
- disposal

For more information on hazards, consult the Material Safety Data Sheet (MSDS) or contact the manufacturer.

For more information on pesticide application, see:

- OMAFRA Factsheet *Calibrating Airblast Sprayers*, Order No. 10-047
- OMAFRA Factsheet *Adjusting, Maintaining and Cleaning Airblast Sprayers*, Order No. 10-069
- OMAFRA Factsheet *How Weather Conditions Affect Spray Applications*, Order No. 09-037w (website only)
- OMAFRA Factsheet *Pesticide Drift from Ground Applications*, Order No. 11-001
- Ontario Pesticide Education Program (University of Guelph, Ridgetown Campus) videos at *www.opep.ca/index.cfm/learning-resources/videos*
- OMAFRA/Agriculture and Agri-Food Canada booklet *Best Management Practices – Pesticide Storage, Handling and Application*, Order No. BMP13
- OMAFRA Factsheet *Pesticide Contamination of Farm Water Supplies – Recommendations on Avoidance, Cleanup and Responsibilities*, Order No. 10-097

Restricted entry intervals

The restricted entry interval, also referred to as Re-Entry Interval (REI), is the period of time following a pesticide application during which workers must not enter the treatment area. This allows any pesticide residue and vapours to dissipate from the treatment location (e.g., field), preventing the possibility of inadvertent pesticide exposure.

The PMRA reviews each pesticide to determine whether the label should include a specific restricted entry interval. If the restricted entry interval is not stated on the label for agricultural crops assume that the REI is 12 hours. For golf courses and other residential turf, the spray solution must be dry before entry can occur. Some pesticides have labels that carry a warning about working in treated crops and provide specific PPE requirements. Follow the label recommendations. See Table 13-2. *Re-entry Intervals for Pesticides and Plant Growth Regulators*, page 263.

Days to harvest for food crops (pre-harvest intervals, pregrazing and feeding intervals)

These intervals state the minimum time that must pass between the last pesticide application and the harvesting of the crop, or the grazing or cutting of the crop for livestock feed. If you harvest a crop before the pre-harvest interval (PHI) has passed, there may be pesticide residues in excess of the maximum residue limits (MRLs) set by PMRA.

"Up to the day of harvest" means the same as 0 days PHI; however, the REI may be more restrictive (i.e., a 12-hr restricted entry interval) and must be observed for harvesting that occurs on the day of application.

To avoid exceeding the maximum residue limits, always follow the directions on the label.

Buffer zones

Buffer zones, or no spray areas, are areas left untreated to protect an adjacent sensitive area, such as sensitive terrestrial and aquatic habitats. Generally, a buffer zone is the downwind distance separating the point of direct pesticide application from the nearest boundary of a sensitive habitat.

Leave a suitable buffer zone between the treatment area and adjacent sensitive areas. Buffer zones may vary depending on the method of application (i.e., aerial, field boom, air blast). Check the pesticide labels for buffer zone requirements.

Sensitive terrestrial habitats include hedgerows, grasslands, shelterbelts, windbreaks, forested areas and woodlots.

Sensitive freshwater habitats include lakes, rivers, streams, creeks, reservoirs, marshes, wetlands and ponds.

Health Canada's Pest Management Regulatory Agency has an online spray drift calculator that allows applicators to modify the buffer zones specified on the product label, based on weather conditions, the category of sprayer or droplet size. For more information, see the Buffer Zone Calculator at *www.hc-sc.gc.ca/cps-spc/pest/agri-commerce/drift-derive/calculator-calculatrice-eng.php.*

Setback Distances for Water Bodies

It is an offence under the federal *Fisheries Act* to introduce into water any material that may be harmful to fish or fish habitat. To protect these waters, applicators must determine a suitable setback distance between the area to be protected and the area where pesticide treatments are planned (if one is not specified on the pesticide label). The protected area includes the water body as well as adjacent riparian (riverbank) areas that contribute to fish food and habitat.

Protect the Environment

Protect water sources

According to the British Crop Protection Council (BCPC), 40%–70% of surface water pesticide contamination comes from mixing and filling areas.

Where possible, load or mix pesticides on impermeable surfaces that are safely away from watercourses or environmentally sensitive areas. Collect drainage and run-off and dispose of it safely (*Your Guide to Using Pesticides*, BCPC 2007).

Clean your spray equipment away from wells, ponds, streams and ditches. Apply the diluted rinse water (usually at a ratio of 10:1) to the treatment area (crop) but do not exceed the pesticide rate recommended on the label.

Do not make a direct connection between any water supply (e.g., public supply, wells, watercourse or pond) and a spray tank. Use an anti-backflow device or intermediate system to prevent back-siphoning that could contaminate the water supply.

Immediately contain and clean up any spills to prevent contamination to water sources.

Check the pesticide label for specific instructions on water source protection.

For more information on protecting water sources, see:

- OMAFRA Factsheet *Pesticide Contamination of Farm Water Supplies – Recommendations on Avoidance, Cleanup and Responsibilities,* Order No. 10-097
- OMAFRA Factsheet *Groundwater – An Important Rural Resource: Protecting the Quality of Groundwater Supplies,* Order No. 06-115
- OMAFRA/Agriculture and Agri-Food Canada booklet *Best Management Practices – Pesticide Storage, Handling and Application,* Order No. BMP13

Bee poisoning

Honey bees, native bee species and other pollinating insects are important pollinators for many Ontario crops. Insecticides, some of which may negatively affect bees, are required for insect control but with careful management, both pollination and insect control can be achieved. Growers and licensed commercial exterminators can protect bees by following these suggestions:

- Before applying a pesticide, advise local beekeepers so they can move colonies out of the danger area. Contact the Provincial Apiarist at 1-888-466-2372, ext. 63595, for a list of the beekeepers in the area or see *www.ontario.ca/crops* and click "Apiculture" for a list of provincial bee inspectors who know the local beekeepers.
- Do not apply insecticides while fruit trees are in bloom. The *Bees Act* makes it an offence to do so in Ontario. Do not spray any flowering crop on which

bees are foraging and read the pesticide label for guidelines.

- Time insecticide applications to minimize bee poisoning. Daytime treatments, when bees are foraging, are most hazardous. Insecticide applications in the evening are the safest. Spraying after 8 PM allows the spray to dry before the bees are exposed to it the next day. This is the most successful way to avoid bee damage. Early morning is the next best time, but spraying should be completed before 7 AM. While honeybees and most other pollinating insects do not usually forage at temperatures below 13°C, bumblebees do. If you plan to spray in the morning, contact beekeepers who have bees within 10 km of your crop. The beekeepers will then have the option of taking protective action.

- Beekeepers can place wet bags in the entrance of the hive to disrupt the flight of the bees for up to 12 hr and provide more time for spray to dry. An opening of 2.5 cm on each side of the hive entrance is necessary so the bees can get out and ventilate the hive.

- Beekeepers should remove honeybee colonies as soon as pollination is complete and before any postbloom insecticides are applied.

- Honeybees may be poisoned by visiting weeds or cover crops, such as dandelions or clovers that are in bloom in the orchard or field. Avoid spray drift to blooming plants that are adjacent to the target field. Where possible, mow down such crops prior to a spray to help safeguard the bees.

- Do not apply insecticide on windy days to prevent drift toward nearby hives.

- If there is a risk of honeybee poisoning, try to choose an insecticide that is not highly toxic to the bees from the list in Table 13-3. *Relative Toxicity of Pesticides to Honeybees*, page 268. When there is a choice, choose a product formulation that is less hazardous to bees. EC formulations are usually less toxic than WP formulations.

Table 13–3. *Relative Toxicity of Pesticides to Honeybees*, page 268, shows the relative toxicity of products to honeybees as determined by laboratory and field tests.

Manage drift

Pesticide drift is the aerial movement and unintentional deposit of pesticide outside the target area. Drift results in wasted product and compromised crop protection, and can adversely affect nearby sensitive environmental areas, crops and wildlife. The following strategies can help reduce the risk of pesticide drift:

- Do not spray when wind speeds are high or gusty. These conditions increase the potential for spray drift. Check pesticide labels for allowable wind speeds for spraying applications. Some labels may not provide this specific information. Constantly monitor wind conditions during spraying, using a good quality wind meter. Record the wind speed and direction. As wind conditions change, you may need to make adjustments to further reduce the drift potential, such as adjusting water volume upwards, minimizing nozzle-to-target distance, changing nozzle technology, changing fields because of surrounding influences or stopping spraying until conditions improve.

- Do not spray during periods of dead calm. Periods of dead calm may occur in early morning or late evening, at which time the temperature is usually cooler and the relative humidity is typically higher and can result in the spray droplets remaining aloft, like fog. When the wind picks up, these spray droplets can move away from the target area, possibly causing injury to adjacent non-target areas.

- Use the recommended sprayer output.

- Use a nozzle that will produce the appropriate droplet size if specified on the pesticide label. Nozzles that produce fine droplets are rarely, if ever, required.

- Use the most appropriate nozzle for the type of application. Where practical, use air induction/venturi nozzles, which significantly reduce drift when compared to conventional nozzles.

- Check the height of the boom to the target, or distance from airblast boom to the target, and minimize the distance as much as possible while still maintaining spray uniformity.

- Follow buffer zone requirements for the protection of adjacent sensitive areas as outlined on the pesticide label.

- Use spray plume protection where practical or available (hoods, shrouds, screens and air curtains).

- Use drift-reducing adjuvants in the spray tank as directed on the label. Sprayer agitators (e.g., paddle or hydraulic return) have been shown to reduce the effectiveness of certain drift-reducing adjuvants.

- Use wick weeders instead of spraying when possible.

- Use non-volatile pesticide formulations or products when possible.

For more information about spray drift, see:

- OMAFRA Factsheet *Pesticide Drift from Ground Applications,* Order No. 11-001
- OMAFRA/Agriculture and Agri-Food Canada booklet *Best Management Practices – Pesticide Storage, Handling and Application,* Order No. BMP13
- Ontario Pesticide Education Program (University of Guelph, Ridgetown Campus) videos *How to Manage Spray Drift* and *Spray Drift Reduction Through Air Induction,* available at *www.opep.ca/index.cfm/learning-resources/videos/chapter-19-drift-of-pesticides/*

Pesticide Disposal

Empty pesticide containers (up to 23 L)

Never re-use empty containers.

The Ontario Empty Pesticide Container Recycling Program is available free of charge to growers and commercial applicators. Through this program, you can return triple-rinsed or pressure-rinsed plastic pesticide containers (up to 23 L) to pesticide container collection depots located throughout the province. Remove the cap and booklet from the pesticide container before recycling. To locate the closest pesticide container collection depot, visit the CleanFARMS™ website at *www.cleanfarms.ca,* call your local dealer or call CleanFARMS™ at 416-622-4460.

Empty pesticide containers (greater than 23 L)

Growers and commercial applicators can return expired pesticide containers that are greater than 23 L in size. Contact your local dealer for details on disposal of these containers or call CleanFARMS™ at 416-622-4460.

Surplus spray mix

The best approach to disposing of surplus spray mix is to avoid creating it by planning the spray job accurately.

Otherwise, dispose of excess spray mix by spraying it on other crops that require an application of this pesticide. Before spraying, check the label to make sure the pesticide is registered for use on that other crop.

If you cannot find another crop to spray, dilute the remaining spray mix by adding 10 parts of water for each 1 part of spray mix. The diluted solution can be safely applied to the original treated area as long as you do not exceed the pesticide rate recommended on the label. Be sure to check the label for any restrictions about crop rotation, days to harvest or surplus spray mix disposal.

Never re-spray the treated field with undiluted spray mix. Spraying an area twice will double the recommended pesticide rate. This may cause illegal pesticide residues in the harvested crop or harmful residues in the soil that can cause crop damage.

Surplus pesticides in storage

Be sure to safely dispose of pesticides that you do not need or cannot use. Options for proper disposal include:

- Contact the supplier. It is sometimes possible to return the unused pesticide if it is still in its original, unopened container.
- Hire a waste hauler who is licensed under Part V of the *Environmental Protection Act* to carry hazardous wastes. Look in the Yellow Pages of your telephone directory under Liquid Waste Removal.
- Check your local paper or visit the CleanFARMS™ website *(www.cleanfarms.ca)* for upcoming Obsolete Pesticide Collection Days.
- Contact your municipality to see if any waste collection days are scheduled and verify whether quantities of agricultural pesticides will be accepted.

Storing Pesticides

Ontario's *Pesticides Act* and Regulation 63/09 provide details on requirements for pesticide storage facilities. The storage requirements that must be followed are dependent on which classes of pesticides you store. See Table 1-1. *Requirements for Pesticide Storage Facilities,* page 6.

For more information about storing pesticides, see:

- OMAFRA Factsheet, *Farm Pesticide Storage Facility,* Order No. 11-005
- OMAFRA/Agriculture and Agri-Food Canada booklet *Best Management Practices — Pesticide Storage, Handling and Application,* Order No. BMP13
- Ontario Pesticide Education Program (University of Guelph, Ridgetown Campus) *Grower Pesticide Safety Course Manual,* available at www.opep.ca. Select Learning

For pesticide poisonings and pesticide injuries, call:

Poison Information Centre:
1-800-268-9017
(TTY) 1-877-750-2233

For more information, see inside back cover on *Emergency and First Aid Procedures for Pesticide Poisoning.*

Table 1-1. Requirements for Pesticide Storage Facilities

	Pesticide Classes			
Storage requirements	**Class 2**	**Class 3**	**Class 4, 5 & 7**	**Class 6**
No contact with food or drink	✓	✓	✓	✓
Not an impairment to health and safety	✓	✓	✓	
Clean and orderly	✓	✓	✓	
Warning sign G posted*	✓	✓	✓	
Emergency telephone numbers posted**	✓	✓	✓	
Vented to outside	✓	✓		
Limited access (locked)	✓	✓		
No floor drain	✓	✓		
Respiratory protection and protective clothing kept readily available	✓	✓		
Area used primarily for pesticides	✓			

Note: Sufficient precautions are needed in your storage area to prevent the pesticide from entering the natural environment. Ensure your floor drain does not enter the natural environment.

* Refer to MOE's website *www.ene.gov.on.ca/en/land/pesticides* for requirements for warning sign G. These signs can be purchased from your pesticide dealer/vendor.

** Emergency contact numbers must include telephone numbers for the local fire department, hospital and poison control centre. The number for the MOE Spills Action Centre (1-800-268-6060) should also be readily available.

Pesticide Spills

If a pesticide spill causes, or is likely to cause, an adverse effect that is greater than that which would result from the proper use of the pesticide, you must notify the Ministry of the Environment Spills Action Centre at 1-800-268-6060 (24 hr a day, 7 days a week) and your municipality.

A spill is defined as a discharge of pollutant that is abnormal in quality or quantity, from or out of a structure, vehicle or other container into the environment. An incident such as an overturned pesticide sprayer that results in the loss of the spray solution to the environment is an example of a spill. A pesticide container that ruptures and leaks its contents is another example of a spill. The discharge or spraying of a pesticide in an unapproved area, commonly referred to as an overspray, is also considered a spill.

Before you begin to clean up a spill of any nature, remember to protect yourself against pesticide exposure. Wear the proper protective clothing and personal protective equipment. If the spill occurs inside an enclosed area (e.g., a pesticide storage area or a vehicle during transport), ventilate the area first. Once you have protected and/or removed yourself and other persons or animals from the spill site, take additional measures to stop the spill at the source and prevent it from spreading and/or contaminating watercourses. Specific precautions, emergency contact information and first aid procedures may be found on the label.

For minor spills, it may be possible to remediate the problem:

- **For a liquid spill** — Cover the spill with a thick layer of absorbent material such as kitty litter, vermiculite or dry soil. Sweep or shovel the material into a waste drum and dispose of the contents as you would a hazardous waste.
- **For a dust, granular or powder spill** — Sweep or shovel the material into a waste drum and dispose of the contents as you would a hazardous waste.

For major spills, it is essential to stop the spill from spreading. The clean-up guidelines above may not be appropriate for all spill situations. Once you have contained the spill, follow directions from the manufacturer and regulatory authorities on cleaning the contaminated area.

For information on preventing spills, see:

- OMAFRA Factsheet, *Ways to Avoid Pesticide Spills,* Order No. 96-025
- OMAFRA/Agriculture and Agri-Food Canada booklet *Best Management Practices – Pesticide Storage, Handling and Application,* Order No. BMP13
- Ontario Pesticide Education Program (University of Guelph, Ridgetown Campus) *Grower Pesticide Safety Course Manual,* available at *www.opep.ca.* Select Online Learning

2. Pest Management

Integrated Pest Management

Integrated Pest Management (IPM) is an approach to pest control that considers all management options to maintain pests below an economic injury level. Tools for pest management include cultural, physical, biological, behavioural and chemical methods. With IPM, adverse effects of pesticides are minimized and economic returns are maintained.

IPM programs make extensive use of information collected in the cropping system and require careful management by the grower. To implement an IPM program it is important to understand:

- pest identification, biology and behaviour
- beneficial organisms
- monitoring techniques
- use and timing of appropriate management tools
- record keeping
- resistance management strategies
- sprayer calibration

For more detailed information see the following publications:

- OMAFRA Publication 310, *Integrated Pest Management for Apples*
- *ONTARIO Crop IPM: Integrated Pest Management Training* available on the OMAFRA website *www.ontario.ca/cropIPM* or in OMAFRA Publication AF141 (CD format).

Monitoring and scouting

Systematic monitoring of pest populations, weather conditions, plant health and disease symptoms is very important to IPM programs. Monitoring is best done by the same person or service. Information on field history, soil type, spray records and weather is important when you interpret monitoring results. Complete records are important for year to year comparisons.

Monitoring can include sampling, the use of traps, and/or visual scouting.

Sampling

- Collect data to represent the entire area monitored.
- Divide large areas into sample blocks no larger than 8–10 ha for tree fruit and grapes, and 2.5 ha for berry crops. Cultivar, training system, plant density, soil type, topography and age of the planting should be as consistent as possible in each sample block.
- Walk in a W or zig-zag pattern across the block to collect samples from a representative area.
- Look away from the plant when you take samples of leaves and fruit, otherwise you will tend to choose damaged leaves or fruit and bias the sample.

Trapping

Use pheromone, baited or visual traps to provide information on pest activity and insect numbers (Table 2-1. *Examples of Traps Used for Monitoring Fruit Pests,* page 8). Trap catches can also be used to initiate and validate degree-day models (described on page 9), which predict the occurrence of key life stages and provide information to optimize spray timing.

Pheromone traps

Pheromone traps use a female sex pheromone lure and some form of trap to attract and capture adult males. The synthetic lure is meant to be specific to each insect species, although closely related species are sometimes attracted to commercial lures. Use pheromone traps to determine the presence or absence of pests and to detect the first sustained flight or activity peaks of certain pests. Pheromone traps are less useful for providing information on population levels and risk of damage.

Insect activity is affected by weather and may be sporadic early in the spring. It is important to note the first sustained catch in pheromone traps. Ignore early sporadic catches. A sustained catch is the start of a continual period of moth activity, which continues for at least two consecutive collection periods. Set up pheromone traps one to two weeks before first flight of the pest is expected.

Visual traps

Colour is an important visual stimulus for insects. Yellow sticky boards and red spheres are attractive to certain fruit pests, especially flies. These traps can indicate the presence and relative abundance of a pest.

How to use traps

- Place traps in the field 1–2 weeks before the expected emergence of the insect.
- Follow pest-specific guidelines concerning the number and location of traps for the crop.
- Clear foliage and branches away from the trap.
- Use separate traps for each species and label traps clearly.
- Pheromone lures are pest-specific. They are very sensitive to contamination from other types of pheromones. When you use several types of pheromones at once, wear disposable gloves to prevent cross-contamination and maintain a minimum of 40 m between traps, or the distance recommended by the manufacturer.
- Use flagging tape to mark the location of traps.
- Check traps twice weekly and record the number of pests caught. Remove the insects at each visit.
- Traps require maintenance. Replace the trap when it becomes too dirty or is no longer sticky. When you replace traps, transfer the old lure into the new trap or replace it if required.
- Pheromone lures generally have a 3–6 week life span but this varies by product and weather conditions. Extreme heat may affect the longevity of lures in the field. Replace the lures according to the manufacturer's instructions. Store unopened, unused pheromone lures in a refrigerator or freezer, as directed by the manufacturer.

For a list of trap and pheromone suppliers, see Appendix A. *Suppliers of Pest Monitoring Equipment and Biological Control Agents,* page 287.

Table 2-1. Examples of Traps Used for Monitoring Fruit Pests

Pest	Crop	Type of Pheromone and/or Trap
Codling moth	• Walnut • Apple	CM pheromone Diamond traps
Walnut husk maggot fly	• Walnut	Yellow sticky cards
Currant fruit fly	• Currant • Gooseberry	Yellow sticky cards
Cranberry fruitworm	• Blueberry	Cranberry fruitworm pheromone Wing traps
Cherry fruitworm	• Blueberry	Cherry fruitworm pheromone Wing traps
Grape berry moth	• Grape	GBM pheromone Diamond traps
Blueberry maggot	• Blueberry	Yellow sticky cards
Spotted wing drosophila fly	• Berry crops • Stone fruit	Fly traps baited with apple cider vinegar or yeast-based mixtures
Obliquebanded leafroller	• Apple • Pear	OBLR pheromone Diamond traps
Peach tree borer	• Stone fruit	PTB pheromone Diamond traps or universal bucket traps with an insecticide strip
Lesser peach tree borer	• Stone fruit	LPTB pheromone Diamond traps or universal bucket traps with an insecticide strip
Dogwood borer, apple clearwing moth	• Apple	DWB or ACM pheromone lure (attracts both species) Diamond traps or universal bucket traps with an insecticide strip
European apple sawfly	• Apple	3-D white sticky traps
Scale insects (crawlers)	• Tree fruit	Double-sided tape

Thresholds

An IPM program uses control guidelines or thresholds to decide when to apply pesticides to prevent economic loss. Some damage to the crop is normally tolerated as long as this damage does not exceed the cost of the control.

For insect pests, thresholds are usually based on the presence of the pest at certain levels. Thresholds for direct pests, which feed on fruit and have an immediate effect on fruit quality, are generally lower than thresholds for indirect pests that feed on leaves, stems or roots. Thresholds may vary depending on the stage of development of the crop or the product being used to manage the pest.

Disease guidelines may be based on damage potential. This is estimated with weather models, crop tolerance, stage of crop development and field observations.

Thresholds have not been developed or validated for all pests in Ontario. Even established thresholds require adjustment for different varieties, markets and crop vigour. Established thresholds may also require revision to optimize the use of new, reduced-risk products.

Use the thresholds in Table 2-2. *Examples of Thresholds Used for Fruit Pests in Ontario,* page 9, together with information on sampling techniques and sample

Table 2-2. Examples of Thresholds Used for Fruit Pests in Ontario

Crop	Pest	Spray Timing	Minimum Sample Size	Threshold	Comments
Strawberries	Tarnished plant bug	Bloom-green fruit	20 flower and fruit clusters	Approx. 0.25 nymphs per cluster	• Sequential sampling methods are preferred. See *Tarnished Plant Bug* on the OMAFRA website at *www.ontario.ca/cropipm.*
Strawberries	Clipper weevil	Before first bloom	5 locations	13 clipped buds per 2 ft² row	• Sample outer rows.
Strawberries	Two-spotted spider mite	Before harvest, or July-August	50 leaflets	Low threshold: 5 mites per leaflet High threshold: 20 mites per leaflet	• Use low threshold on sensitive varieties before bloom or when using beneficial mites for control. • Use high threshold after harvest.
Raspberries	Raspberry crown borer	October, or when primocanes begin to grow in spring	Entire block	5% of canes with die-back	
Apples	Mullein bug	Petal fall to calyx	25 taps per block	7–9 nymphs per 25 taps	• Sample susceptible varieties such as Red Delicious and Northern Spy.
Apples	Spotted tentiform leafminer	Pink to calyx	50 spurs	3–5 eggs per spur	• Apply insecticide at first egg hatch.
Grapes	Potato leafhopper	Early summer after surrounding alfalfa hay is cut	Entire block	In established blocks: 25% or more of young leaves with symptoms In 1st or 2nd year plantings: 10% of young leaves with symptoms	• Apply insecticide when most of the population is in the nymphal stage. • Symptoms include yellowing along the leaf edge and leaf curling.

size, crop growth stage, spray times and pesticide characteristics discussed in detail in each crop chapter.

Degree-day modeling and determining a biofix

Temperature, light and moisture affect the growth and development of plants and pests. Of these, temperature is the most important factor for insect and mite development. These pests need a certain amount of heat to move to the next development stage.

The amount of heat required for insect and mite development remains constant from year to year, but depending on weather conditions, the amount of actual time that it takes to complete development can vary. Insects and mites have a minimum and maximum base temperature below or above which development does not occur. These base temperatures are different for each organism.

Degree-Days Celcius (DDC) are used to estimate the growth and development of pests in the growing season (see Table 2-3. *Examples of Degree-Day Models Used in Fruit Crops,* page 10). Events such as egg-laying, egg hatch, movement of crawlers or the occurrence of disease infection can be predicted and used to schedule inspection and spray programs. For example, degree-day calculations can predict the first hatch of codling moth eggs or the percentage of apple scab ascospores that have matured in the orchard.

There are several methods used to calculate DDC, but the method commonly used with simple monitoring equipment is the averaging method or "max/min" method. DDC for a given organism are calculated as follows:

$$\text{DDC} = \frac{(\text{Daily max °C})+(\text{Daily min °C})}{2} - \text{minimum base temperature}$$

Degree-Days Celcius are accumulated daily. The averaging method works well in most years. However, the actual DDC accumulations may be underestimated in extended periods of cool weather or overestimated in hot weather.

An example of the averaging method on a relatively cool spring day:

For a given pest:
Lower base temperature = 10°C
Upper base temperature = 35°C

On a given day:
Minimum temperature = 5°C
Maximum temperature = 15°C
Degree-Days Celcius (DDC) for that day is = (15 + 5)/2 – 10 = 0

Table 2-3. Examples of Degree-Day Models Used in Fruit Crops

Pest	Base Temperature	Predicted Event		Model
Tarnished plant bug (strawberries)	12.1°C	1st nymphs in strawberries		• 30–40 DDC after April 1
Codling moth (apples)	10°C	1st egg hatch		• 139 DDC after first sustained moth catch (biofix)
Obliquebanded leafroller (apples)	6.1°C	1st egg hatch		• 220–244 DDC after first sustained moth catch (biofix)
Oriental fruit moth (peach)	7.2°C	1st generation	10% egg hatch 55% egg hatch end of egg hatch	• 95 DDC after first sustained moth catch (biofix) • 195 DDC after first sustained moth catch (biofix) • 359 DDC after first sustained moth catch (biofix)
		2nd generation	10% egg hatch 55% egg hatch end of egg hatch	• 639 DDC after first sustained moth catch (biofix) • 780 DDC after first sustained moth catch (biofix) • 1083 DDC after first sustained moth catch (biofix)
		3rd generation	10% egg hatch 55% egg hatch end of egg hatch	• 1167 DDC after first sustained moth catch (biofix) • 1375 DDC after first sustained moth catch (biofix) • 1765 DDC after first sustained moth catch (biofix)

* Spray timings are based on egg hatch, and depend on the product used.

Note that the maximum temperature was higher than the base temperature for the insect, so growth and development were possible for at least part of the day. However, no DDC were accumulated. This illustrates how cool temperatures, especially over several days, could lead to an underestimation of insect development.

Degree-Days Celcius are either accumulated from a set start date, such as April 1, or from a specific event known as a biofix. A biofix is a biological event or indicator of a developmental event, that initiates the beginning of DDC calculations. A common biofix used for insects is the first sustained catch in pheromone traps. Using a biofix provides predictions that are more accurate and requires tracking temperatures over a shorter period.

There are several limitations to degree-days models:

- Factors such as humidity, light intensity and rainfall also affect pest development. As a result, DDC predictions are only estimates of pest development. Verify these predictions with field observations.
- Temperatures used to determine DDC must represent the environment where organisms develop. Use weather data collected from within a mile or less of the actual orchard or field being monitored. Site specific information can be obtained by using data loggers. Ventilated heat shields should be used with temperature sensors data loggers to ensure accurate air temperatures. Place data loggers at locations in the crop where the pest is normally active.
- DDC models have been developed and validated for only a few fruit pests in Ontario.

For a list of available crop consultants providing monitoring services, contact OMAFRA's Agricultural Information Contact Centre at 1-877-424-1300, or the nearest OMAFRA Resource Centre.

Pest Management Tools

Cultural pest controls

Many crop management practices can prevent or delay the development of pest outbreaks. Use these cultural control methods:

- Choose sites less favourable for pest development. Avoid planting in poorly drained locations.
- Select cultivars less susceptible to disease or insect pressure (see Table 5-24. *Strawberry Variety Disease Ratings*, page 135 and Table 6-5. *Relative Susceptibility of Grape Cultivars to Diseases*, page 158).
- Where possible, rotate to a non-host crop to break the pest cycle. Some insects and many diseases overwinter in crop debris.
- Use plants tested and determined to be free from virus diseases, and grown according to guidelines that minimize the presence of other pests.

Table 2-4. Examples of Classical Biological Control in Ontario Fruit Crops

Pest	Imported natural enemy and area of origin	How it works	Comments
European apple sawfly	*Lathrolestes ensator* (Brauns) from Europe	A wasp that parasitizes larva of European apple sawfly	Imported from Europe and introduced to unsprayed orchard blocks and commercial orchards in Quebec and Eastern Ontario.
Tarnished plant bug	*Peristenus digoneutis* from Europe	A tiny wasp that parasitizes eggs of tarnished plant bug	Introduced in alfalfa in New Jersey and found to spread naturally to locations throughout Ontario. Attempts to establish this parasite in organic strawberry farms in Ontario are in progress.

- Remove all sources of the pest, such as cull piles and dropped fruit, from the field or orchard.
- Maintain good weed control and eliminate wild hosts from within as well as the perimeter of the planting. Weeds and wild fruit trees, grapevines and brambles often act as alternate hosts for many crop pests.
- Use non-related crops planted in close proximity as a barrier to insects and diseases. Avoid inter-cropping plants with similar pest complexes.
- Modify insect habitat through the introduction of cover crops to promote beneficial organisms.
- Prune and remove infected plant material to reduce pest pressure. Pruning and training plants to improve air movement within the canopy will also improve spray coverage.
- Timely irrigation can reduce plant stress during drought and increase plant tolerance to pests. Schedule irrigation so that plants are not wet overnight.
- Manage nutrients to avoid excessively lush growth, which is more susceptible to some diseases and more attractive to some insect pests.

Biological control

Biological control uses a pest's natural enemies to help suppress pest populations. These biological control agents may be predatory insects, parasites, pathogens or nematodes.

Predatory and parasitic insects are most effective against indirect pests such as aphids, leafhoppers and mites. They are less effective at keeping populations of direct pests, which attack the harvested product, at levels acceptable for commercial production. Important insects and mites for biological control include ground beetles, mullein bugs, minute pirate bugs, lacewings, lady bird beetles and phytoseiid mites.

Natural pathogens of insects and mites include bacteria, viruses, fungi and protozoa. Pathogens circulate naturally in insect populations. Under the right conditions, they can cause disease outbreaks in insects, which can significantly reduce insect populations. Aphids and caterpillars are routinely infected by cycles of viral or fungal disease, which thrive when the environment is moist.

Several approaches to biological control are used in Ontario fruit crops: classical biological control, augmentation of natural enemies from commercial sources, and conservation of existing natural enemies.

Classical biological control

Classical biological control is based on importation of natural enemies, in hopes that they will become established in their new environment (Table 2-4. *Examples of Classical Biological Control in Ontario Fruit Crops*, on this page). This method is generally used to manage introduced or exotic pests, which have few natural enemies in their new habitat. Classical biological control is a long term strategy that can take years or decades to become effective. Strict protocols are in place to ensure that introduced species of beneficial insects do not become pests in their new location.

Augmentation

Augmentation involves increasing the populations of natural enemies using periodic releases from commercial sources (Table 2-5. *Examples of Augmenting Natural Enemies from Commercial Sources*, page 12).

This practice is very successful in greenhouses and controlled environments. Control is less consistent in outdoor settings and is affected by pesticide use, environmental conditions, pest density and the crop. Some species of biological control agents require alternative food sources to prevent starvation when pest populations are low. Product quality and shelf life are important considerations when using biological control agents. For sources of beneficial insects and mites, see Appendix A. *Suppliers of Pest Monitoring Equipment and Biological Control Agents*, page 287, or check *Sources of Crop Inputs* at *www.ontario.ca/crops*.

Table 2-5. Examples of Augmenting Natural Enemies from Commercial Sources

Biological control agent	Examples	Pest	Common crop uses	Application rates	Comments
Predatory mites	*Phytoseiulus persimilis*	Two spotted spider mite (TSSM)	Strawberry, raspberry especially in high tunnels	First sign of mites: 3–4 individuals/m^2 Hot spots: 10–20 individuals/m^2	Performs best in 75% or higher humidity. Requires mites for food. Do not introduce until first TSSM are observed.
	Amblyseius californicus *Amblyseius fallacis*	Two spotted spider mite	Strawberry, raspberry, especially in high tunnels	Preventive: 1–2 individuals/m^2 Hot spots: 4–6 individuals/m^2	Performs best in warm, dry conditions. Can feed on pollen in absence of prey.
Nematodes that feed in insect larvae (entomopathogenic nematodes)	*Heterorhabditis megidis* *Steinernema kraussei*	Root weevil larvae	Strawberry	25,000 nematodes per plant (approx 1.2–5 billion nematodes/ha)	Apply to moist soil as a drench or through irrigation system when root weevil larvae are present. Be aware of the soil temperature and use the appropriate product for these soil conditions.

When using biological controls is it important to monitor pest and predator populations to determine the need for reapplication. Choose pesticides carefully as they can have short and long-term negative effects on one or more stages of predatory mites. For detailed information on how to use biological control in fruit crops, contact the product supplier. See Appendix A. *Suppliers of Pest Monitoring Equipment and Biological Control Agents,* page 287.

Conservation

Conservation involves protecting natural enemy populations. This is achieved mainly by careful choice and timing of pesticides. IPM programs attempt to minimize adverse effects of pesticides on beneficials. For example, avoiding the use of organophosphate insecticides after petal fall will help conserve *Pholetesor ornigis,* an important parasite of tentiform leafminer in apples. The use of certain fungicides can negatively affect the performance of certain fungal diseases of aphids, beetles, and other pests.

The crop environment and surrounding habitat can affect natural enemy populations. IPM programs also aim to provide habitat for beneficial insects. Border crops and hedgerows provide refuges for natural enemies and flowering plants in these habitats provide nectar for food.

Follow these practices to conserve beneficial insects in fruit crops:

- Avoid use of pesticides that are toxic to the most important beneficials in a cropping system. See *Bee Poisoning,* page 267, and Table 4-11. *Toxicity of Pesticides to Mite and Aphid Predators,* page 63.

- Encourage a diverse habitat around the perimeter of the field where beneficial insects can live. Small flowering plants are an important food source for parasitic wasps.

- Avoid ultra-clean cultivation. Crop residue, mulch or ground cover will encourage ground beetles and other important predators in the soil.

- For additional information on predators and parasitoids, see OMAFRA Publication 208, *Predatory Insects in Fruit Orchards.*

Control with pesticides

Chemical controls include synthetic, inorganic, botanical and biological pesticides. They kill target pests, limit subsequent populations and are important tools for crop protection when used in an IPM program.

Understand the pest's life cycle and apply chemicals at the stage when the pest is most vulnerable. To manage insects and mites, monitor blocks closely and spray according to action thresholds established for each species. To manage disease, apply protective fungicides when weather conditions are favourable and before damage occurs.

Efficacy ratings for pesticides

All insecticides/miticides and fungicides are evaluated by the Pest Management Regulatory Agency for efficacy. Wording on the product label such as control, suppression, and reduction in damage is used to describe the efficacy of these products. The definitions for "control" and "suppression" for insecticides have a somewhat different meaning than the same terms applied to fungicides, as shown in Table 2-6. *Efficacy Ratings for Insecticides/Miticides and Fungicides,* page 13.

Table 2-6. Efficacy Ratings for Insecticides, Miticides and Fungicides

Pesticide	Term to describe efficacy	Defined as
Insecticide Miticide	Control	• The product, when applied in accordance with the label directions, consistently reduces pest numbers or pest damage to a commercially acceptable level.
	Suppression or Partial suppression	• The product, when applied in accordance with the label directions, does not consistently reduce pest numbers or pest damage to a commercially acceptable level. Under such situations, the level of performance offered by the product must still have value in a pest management program. • Partial suppression claims are most likely to be used for non-conventional pesticides.
Fungicide	Control	• The product, when applied in accordance with the label directions, consistently reduces disease incidence and severity to a commercially acceptable level and protects yield potential.
	Suppression	• Consistent control at a level which is not optimal but is still of commercial benefit. Suppression is not used for products which show highly variable performance.

For direct pests which cause damage to the fruit, it is important to choose products which provide control rather than suppression. However, if the pest is an indirect pest, and does not affect fruit directly, products labelled for suppression may be useful. Together with natural enemies or biological control, products used for suppression might be enough to prevent significant crop damage. Products labelled for suppression may also play a role in resistance management. By alternating with products from different families, the risk of pest resistance to important products can be reduced.

Price and intended markets play a big part of the decision to use products for suppression. Sometimes there are no other options for organic pest management. However, when using a new product for pest suppression, try to leave an untreated check and evaluate the benefits of using these products compared to the cost of application.

Pest Management for Organic Fruit Growers

Pest management in organic fruit production includes pest monitoring, field sanitation, crop rotation, and use of resistant varieties and other crop management practices to encourage beneficial insects and to minimize pest outbreaks.

Several new pest management tools have been developed for fruit production that will assist growers in controlling major pests in commercial fruit crops. For more information on some tools available to organic producers see *Cultural pest controls,* page 10, *Biological control,* page 11, *Biopesticides,* page 241, and *Using Mating Disruption in Fruit Crops,* page 248.

All pest control products used on fruit crops must be labelled and registered for the pest and for the crop on which they are used. In addition, products used for organic fruit production must meet the requirements of the Canadian Organic Standards, and any additional requirements of the local organic certification body. Products that have been reviewed and listed by the Organic Materials Review Institute (OMRI listed) may be acceptable for use in organic production if they are registered in Canada. However, they must also be approved by the certification body. Not all formulations of an active ingredient may be organically acceptable. For example, the biopesticide *Bacillus thuringiensis* is formulated into multiple products for fruit crops, but only a few of these are acceptable for use by organic producers. Always check with your organic certification body to confirm which products are allowed for use in your situation.

There are several certification bodies serving Ontario farms and processors. Contact these organizations to get information on how to be certified. For more information on certification, as well as addresses and links to details of the organic regulations and standards see the infosheet *Organic Food and Farming Certification* at *http://omafra.gov.on.ca/english/crops/organic/certification.htm.*

Products for organic fruit production

Table 2-7. *Products for Organic Fruit Production,* page 14, lists products registered in Ontario and may be acceptable for organic production. Always check with your organic certification body to confirm which products are allowed for use in your situation.

For more details on these products, see Table 13-5. *Pesticides Used on Fruit Crops in Ontario,* page 272 and Table 11-2. *Characteristics of Biopesticides Registered on Fruit Crops,* page 244.

Table 2-7. Products for Organic Fruit Production

Insecticides for organic fruit production[1]

Product	Active ingredient	Crop registrations (use only for pests on the label)
Bioprotec CAF	*Bacillus thuringiensis* subsp. kurstaki	apple, apricot, blueberry, cherry, peach, pear, plum, raspberry, sea buckthorn
Bio-Save 10 LP	*Pseudomonas syringae*	apple, pear, cherry
CYD-X	granulosis virus	apple
DiPel 2X DF	*Bacillus thuringiensis* subsp. kurstaki	apple, apricot, blueberry, cherry, currant, elderberry, grape, hazelnut, pear, pecan, plum, raspberry, Saskatoon berry, sea buckthorn, strawberry, sweet chestnut, walnut
Entrust 80 W	spinosad	apple, apricot, blueberry, cherry, currant, elderberry, grape, peach, pear, plum, raspberry, sea buckthorn, strawberry
GF-120	spinosad	apple, blueberry, cherry, walnut
Isomate-CM/OFM TT	codling moth and oriental fruit moth pheromone	apple, cherry and other stone fruit, peach, pear, walnut
Isomate-GBM Plus	grape berry moth pheromone	grape
Isomate-M100	oriental fruit moth pheromone	apple, apricot, peach, pear
Isomate-M Rosso	oriental fruit moth pheromone	apple, apricot, peach, pear
Isomate-P	peach tree borer pheromone	apple, apricot, cherry, peach, pear, plum
Kumulus DF	sulphur	apple, pear, peach, plum, cherry, grape, Saskatoon berry
Microthiol Disperss	sulphur	apple, pear, peach, plum, cherry, grape, Saskatoon berry
Opal Insecticidal Soap	potassium salts of fatty acids	nut trees, apple, apricot, cherry, peach, pear, plum, grape, strawberry, blueberry, raspberry, cranberry
Purespray Green Spray Oil 13E	mineral oil	apple, apricot, highbush blueberry, peach, pear, plum, Saskatoon berry, sour cherry
Sluggo Professional	ferric phosphate	fruits and berries
Superior Oil 70	mineral oil	apple, apricot, highbush blueberry, peach, pear, plum, Saskatoon berry, sour cherry
Surround WP	kaolin	apple, butternut, grape, hazelnut, pear, pecan, raspberry, strawberry, sweet chestnut, walnut
Virosoft CP4	granulosis virus	apple

Fungicides for organic fruit production[1]

Product	Active ingredient	Crop registrations
Actinovate SP	*Streptomyces lydicus* strain WYEC 108	strawberry (field and greenhouse)
Bloomtime Biological	*Pantoea agglomerans*	apple, raspberry, Saskatoon berry
Copper 53W	copper from tri-basic copper sulphate	apple, currant, gooseberry, grape, nectarine, peach, pear, sour cherry, strawberry
Copper Spray	fixed copper	apple trees, cranberry, filbert/hazelnut, grape, highbush blueberry, peach, raspberry, sour cherry, walnut
Kumulus DF	sulphur	apple, cherry, grape, peach, pear, plum, Saskatoon berry
Lime Sulphur	lime sulphur	blueberry, grape
Microthiol Disperss	sulphur	apple, cherry, grape, peach, pear, plum, Saskatoon berry
MilStop	potassium bicarbonate	apricot, grape, peach, plum
Rootshield HC	*Trichoderma harzianum*	strawberry
Serenade ASO Serenade Max	*Bacillus subtilis*	apple, apricot, blackberry, blueberry, cherry, currant, elderberry, gooseberry, grape, pear, plum, raspberry, Saskatoon berry, sea buckthorn, strawberry

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[1] May not be a complete list. Always check with your organic certification body to confirm which products are allowed for use.

3. Soil Management, Fertilizer Use, Crop Nutrition and Cover Crops

For a complete guide to soil fertility, consult OMAFRA Publication 611, *Soil Fertility Handbook.*

Crop nutrition is important in the production of high yielding, top quality fruit crops. Nutrients must be dissolved in the soil water for root uptake. Good soil and water management practices are important for a crop's efficient use of nutrients from organic and inorganic fertilizer. The development of a sound soil fertility program begins with the assessment of nutrient needs.

Assessing Nutrient Needs

There are three inter-dependent ways to assess soil and crop fertility:

- soil-testing
- plant tissue analysis
- visual deficiency symptoms

For perennial crops, all three methods are needed to assess and monitor the crop's nutritional status.

Soil testing

A soil test using methods suited to the particular soil type is the best measure of plant-available nutrients. OMAFRA accredits specific laboratory methods suited to Ontario soils (see Table 3-1. *OMAFRA-Accredited Soil Tests,* on this page). OMAFRA accredited laboratories participate in the North American Proficiency Testing Program and must demonstrate their ability to perform these tests accurately. Soil laboratories may provide additional soil tests not listed in Table 3-1, as well as analyses for greenhouse media, nutrient solutions and water. Testing for soil organic matter can be useful but is not an accredited test. OMAFRA-accredited soil tests are not available for boron, copper, iron or molybdenum. For other testing services, contact the soil laboratories listed in Appendix C. *Accredited Soil-Testing Laboratories in Ontario,* page 289. Tissue analysis of these micronutrients is a better indicator of the nutritional status.

When to sample

Always take soil samples before you plant fruit crops. Where pH adjustments may be necessary, sample two years before planting so that pH adjustments can be made. After establishment, sample each field once every two or three years. In sandy soils, consider checking soil potassium levels more frequently.

Table 3-1. OMAFRA-Accredited Soil Tests

See Appendix C. *Accredited Soil-Testing Laboratories in Ontario,* page 289, for a list of accredited labs in Ontario.

Nutrient Analyzed	Test
phosphorus	sodium bicarbonate extractable
potassium, magnesium	ammonium acetate extractable
manganese	index of soil pH and phosphoric acid extractable manganese
zinc	index of soil pH and DTPA extractable zinc
pH	saturate paste extract
lime requirement	SMP buffer pH
soil nitrate	potassium chloride extraction

Soils may be sampled in the summer or fall. Sample at the same time each year for more consistent sample results. Late summer or fall sampling is ideal for fields to be planted in the spring. Regardless of when you sample, allow time to mail the samples, receive your report and determine fertilizer requirements.

Taking a soil sample

Soil test report accuracy and the recommendations that result depend on the proper collection, preparation and submission of a soil sample. To take a soil sample you will need:

- soil probe or a shovel
- clean plastic pail (avoid galvanized metal pails, which will contaminate the sample for micronutrient analysis, particularly zinc)
- sample bags and boxes, usually available from the soil laboratory
- a pen or marker

Sample each field or individually managed unit separately. Separate large fields, or fields with considerable variation, into smaller sections. Each sample should represent a field or field section with similar soil texture, topography, organic matter and crop history.

Sample soils with a sampling tube or shovel. Sample each field or uniform section of a field separately.

Traverse the sampled area in a zigzag pattern to provide a uniform distribution of sampling sites. Take at least 20 soil cores, 15 cm deep, from any field or area sampled up to 5 ha (12.5 ac.) in size. For fields larger than 5 ha, proportionately more cores should be taken. The more cores taken, the more likely the sample will provide a reliable measure of the fertility in the field. One sample should not represent more than 10 ha.

Where parts of a field differ in soil type, crop grown or previous fertilization practices (manuring or liming), sample separately. This applies even if the areas are too small to fertilize separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads, or where lime, manure, compost or crop residues have been piled.

Collect the soil in a clean plastic pail, break up the lumps and mix the soil well, since only about 2 mL of soil from the sample will be used for each analysis. Fill a clean plastic bag with approximately 500 g of soil, place it into the box and forward it for testing. Be sure to clearly mark the sample box with all of the necessary information (i.e., sample number, farm name, date, etc).

Micronutrient deficiencies most often occur in small patches in fields. In these cases, soil or plant samples representing the entire field are unlikely to show a problem. Sample problem areas separately. When you sample a problem area, be sure to take a comparison sample from an adjacent area without symptoms.

Samples to assess soil nitrogen should be taken following the same sampling method, except they are taken to a depth of 30 cm and must be kept cool or frozen if not submitted immediately.

Interpreting soil test results

The OMAFRA-accredited soil-testing program provides recommendations for nitrogen, phosphate, potash, magnesium, zinc and manganese fertilizer. It also gives recommendations for the amount and type of lime to be applied, if required. These recommendations are specific to the future crop to be grown, specified on the lab submission form. Crop specific details may be found on the following pages:

Apples	page 33
Berry crops	page 85
Grapes	page 137
Tender fruit	page 161

These recommendations can produce the highest economic yields when accompanied by good or above-average crop management.

On a soil test report, each nutrient is reported in parts per million (ppm) or milligrams per litre (mg/L) of soil, a letter rating and a fertilizer recommendation (usually kg/ha or lb/ac). The letter rating of the nutrient indicates the likelihood of a profitable response to applied nutrient for the specified crop. This letter rating system is explained in Table 3-2. *Soil Test Nutrient Ratings*.

Table 3-2. Soil Test Nutrient Ratings

Response category	Probability of profitable response to applied nutrients
High Response (HR)	High (most of the cases)
Medium Response (MR)	Medium (about half the cases)
Low Response (LR)	Low (few of the cases)
Rare Response (RR)	Rare (very few of the cases)
No or Negative Response (NR)	Not profitable to apply nutrients

A fertilizer recommendation depends on the crop to be grown. Recommended fertilizer rates, especially for nitrogen and phosphorus, should be adjusted if manure or legume cover crops are incorporated. This information is essential for an optimum fertilizer recommendation.

Soil tests from other laboratories

OMAFRA-accredited soil tests provide accurate fertilizer recommendations. Make certain that the service you use is accredited. To be accredited, a laboratory must use OMAFRA-approved testing procedures to demonstrate acceptable analytical precision and accuracy and must also provide the OMAFRA fertilizer recommendations. Ensure that you ask for the OMAFRA fertilizer recommendations. Soil tests for nutrient management plans must be completed at OMAFRA-accredited labs. Soil tests for exchange capacity, aluminum and copper are not accredited by OMAFRA because they have not been found to contribute to better fertilizer recommendations.

Plant tissue analysis

Plant tissue analysis measures the nutrient concentration in plant tissue. It is most useful if combined with visual inspection of the crop and soil conditions, knowledge of past management in the field and a current soil test to provide information about soil nutrient levels and soil pH. See Table 3-3. *Sampling for Tissue Analysis of Fruit Crops,* page 17.

For perennial crops, tissue analysis is an important addition to soil tests. Tissue analysis results are compared against established normal ranges for the crop and indicate whether a specific nutrient is deficient. The tissue test can indicate whether the plant is obtaining

Table 3-3. Sampling for Tissue Analysis of Fruit Crops

Crop	Stage of growth/timing	Plant part sampled	Approximate number to collect
Apple	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height from all sides of tree	10 leaves from 10 representative trees
Blueberry, Highbush	Late July–early August	Mature mid-shoot leaves of current year growth	100 leaves throughout sampling area
Cherry, Montmorency	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height	10 leaves from 10 representative trees
Grapes	Early September	Petioles from mature leaves of fruiting canes – remove from leaf immediately	75–200 depending on variety size
Peach	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height	10 leaves from 10 representative trees
Pear	Last 2 weeks of July	Mature mid-shoot leaves of current year growth at shoulder height	10 leaves from 10 representative trees
Raspberry	Late July	Fully expanded leaves from fruiting cane	100 leaves throughout sampling area
Strawberry	Fruiting – June Non fruiting – early August	Fully expanded, recently matured leaf blade – discard petiole immediately	50 blades throughout sampling area

adequate nutrients for optimum growth. If soil levels are known to be adequate, tissue tests that indicate nutrient deficiencies should trigger a search for other causes. Plant analysis is particularly useful for the evaluation of phosphorus, potassium, magnesium and manganese. It is the main tool for assessing the status of boron, copper, iron and molybdenum, as there is no reliable soil test for these micronutrients.

Sampling

The time a sample is collected and the stage of growth can have a major impact on the results of plant analysis. The concentrations of some nutrients vary considerably with the age of the sampled tissue and the date of sampling. Results are difficult to interpret if samples are taken at times other than what is recommended for the crop.

- Collect tissue samples into labelled paper bags. Plant tissues will rot if stored in plastic bags.
- Avoid collecting damaged leaves or leaves from plants that appear abnormal.
- If variable areas are large enough to fertilize separately, they should be sampled separately.
- Avoid contamination of the sample with soil. Even a small amount of soil will cause the results to be invalid, especially for micronutrients.
- Plants suspected of nutrient deficiency should be sampled as soon as a problem appears. Take tissue samples from a problem area and submit a separate sample from an adjacent, non-affected part of the field. Also collect and submit a soil sample from both affected and non-affected areas to aid diagnosis.

Sample preparation

Fresh plant samples should be delivered directly to the laboratory. If they cannot be delivered immediately, they should be dried to prevent spoilage. Samples may be dried in the sun or in an oven at 65°C or less.

Take precautions to prevent contamination with dust or soil. Avoid contact of samples with brass, copper or galvanized (zinc-coated) metal.

Plant analyses may be obtained from several laboratories in Ontario. Refer to Appendix C. *Accredited Soil-Testing Laboratories in Ontario,* page 289. Tissue analysis is not part of the OMAFRA accreditation program. However, OMAFRA-accredited labs have the necessary skills and equipment to perform accurate tissue analysis.

Interpretation

Tissue analysis has limitations and expert help is sometimes needed to interpret the results. Tissue analysis does not indicate how much fertilizer is required to correct a deficiency or even whether a deficiency is related to fertility problems. Tissue test results in the deficiency range may also be due to factors such as climate, pest pressure or disease, and therefore should be used in conjunction with a soil-testing program. Table 3-4. *Nutrient Concentration Sufficiency Ranges for Fruit Crops,* page 18, shows the range of tissue nutrient concentration that should result in optimum productivity for various fruit crops.

Table 3-4. Nutrient Concentration Sufficiency Ranges for Fruit Crops

Crop	N	P	K	Ca	Mg	Fe	B	Cu	Zn	Mn
	%					ppm				
Apple[1]										
Delicious, Crispin	2.2–2.7	0.15–0.4	1.4–2.2	0.8–1.5	0.25–0.4	25–200	20–60		15–100	20–200
Empire, Spy	2.1–2.6	0.15–0.4	1.3–2.1	0.7–1.5	0.25–0.4	25–200	20–60		15–100	20–200
McIntosh, Others	2–2.5	0.15–0.4	1.2–2	0.8–1.5	0.25–0.4	25–200	20–60		15–100	20–200
Berry Crops										
Blueberry, Highbush	1.7–2.3	0.15–0.4	0.36–0.7	0.3–0.8	0.12–0.3	30–100	15–50		10–100	150–500
Raspberry	2–3.5	0.20–0.5	1–2	0.8–2.5	0.25–0.5	25–200	20–60	5–20	15–100	20–200
Strawberry	2–3	0.20–0.5	1.5–2.5	0.5–1.5	0.25–0.5	25–200	20-60		15–100	20–200
Grapes (Petioles)										
Vinifera	0.8–1.4	0.15–0.4	1.2–2.3	1–3	0.6–1.5	15–100	20–60		15–100	20–200
Fredonia	0.6–1.2	0.15–0.4	0.8–1.8	1–3	0.6–1.5	15–100	20–60		15–100	20–200
Other	0.7–1.3	0.15–0.4	1–2	1–3	0.6–1.5	15–100	20–60		15–100	20–200
Tender Fruit										
Peach	3.4–4.1	0.15–0.4	2.3–3.5	1–2.5	0.35–0.6	25–200	20–60		15–100	20–200
Pear	2–2.6	0.15–0.4	1.2–2	1–2	0.25–0.5	25–200	20–60		15–100	20–200
Plum	2.4–3.2	0.15–0.4	1.5–3	1–2.5	0.35–0.65	25–200	20–60		15–100	20–200
Cherry (Montmorency)	2.2–3	0.15–0.4	1.3–2.5	1–2.5	0.35–0.65	25–200	20–60		15–100	20–200

[1] Leaf nitrogen should be 0.2% higher for apple trees on M.9 or M.26 rootstocks and for all non-bearing trees.

Visual deficiency symptoms

Leaf symptoms can help evaluate some nutrient deficiencies, but have limitations. By the time deficiency symptoms are visible, yield losses may already have incurred. Visual deficiency symptoms are easily confused with other production problems such as pesticide injury, leaf and root diseases, nematodes, insect damage, compaction or air pollution. Suspected visual deficiencies should always be confirmed by tissue analysis. Specific nutrient deficiency symptoms are described in *Apple Nutrition,* page 33; for *Berry Crop Nutrition,* page 85; *Grape Nutrition,* page 137; and, *Tender Fruit Nutrition,* page 161.

Soil Organic Matter

Soil organic matter helps maintain soil structure, enhances soil moisture holding capacity, increases the ability of the soil to hold nutrients and improves drainage. Adequate soil organic matter levels can help maintain crop yields and long-term plant health, especially in adverse weather conditions. Many horticultural soils are light-textured and frequently cultivated. The maintenance of organic matter levels in these soils is a challenge but critical to maintain productivity.

To ensure long-term productivity of fruit crops, assess the soil quality of each field before planting and take steps to maintain or improve it. For more information, see OMAFRA Publication 611, *Soil Fertility Handbook.* and Table 3-5. *Optimum Soil Organic Matter Contents for a Range of Soil Types.*

Table 3-5. Optimum Soil Organic Matter Contents for a Range of Soil Types

Soil type	Optimum % organic matter
Sandy soils	2–4 +
Sandy loam soils	3–4 +
Loam soils	4–5 +
Clay loam soils	4–5 +
Clay soils	4–6 +

Source: The Canada-Ontario Environmental Farm Plan Program workbook, 3rd ed. 2004.

Soil pH and Liming

The pH scale ranges from 0 to 14 and is a measure of the hydrogen ion concentration. A pH value of 7.0 is neutral. Values below 7.0 are acidic. Those above 7.0 are alkaline, also called basic. On mineral soils, most fruit crops grow well in a soil pH range from 6.0 to 7.5. Blueberries require a range of 4.2 to 5.0. Maintenance of a soil within the appropriate pH range is important.

Many crop nutrients, especially micronutrients, become less available at a soil pH above or below the ideal range. At a low soil pH, less than 5.0, levels of aluminum and manganese may be toxic for sensitive crops.

Raising pH

Soil pH is increased through the broadcast and incorporation of ground limestone into the soil. The amount of lime needed is determined by the soil test results. Table 3-6. *Soil pH at which Lime is Recommended for Ontario Field-Grown Crops,* on this page, shows pH values below which lime is recommended and the target soil pH to which soils should be limed. In Ontario, most crops grow quite well at pH values higher than the target pH for which lime is recommended.

Table 3-6. Soil pH at which Lime is Recommended for Ontario Field-Grown Crops

	Soil pH below which lime is recommended	**Target soil pH**
Coarse and Medium Textured Mineral Soils (sands, sandy loams, loams and silt loams)		
All crops not listed below	6.1	6.5
Corn, soybeans, winter rye, grass hay and pasture, turf, tobacco, established tree fruits and grapes	5.6	6.0
Potatoes	5.1	5.5
Blueberry, cranberry, rhododendron, azalea	No lime recommended	
Fine Textured Mineral Soils (clays and clay loams)		
Alfalfa, cole crops, rutabagas	6.1	6.5
All crops not listed above or below	5.6	6.0
Corn, rye, grass hay and pasture, tobacco, established tree fruits and grapes, potatoes	5.1	5.5
Blueberry, cranberry, rhododendron, azalea	No lime recommended	
Organic Soils (peats and mucks)		
All crops not listed below	5.1	5.5
Blueberry, cranberry, rhododendron, azalea	No lime recommended	

Buffer pH

The soil pH measures the amount of acidity in the soil solution, indicating whether liming is necessary for crop production. It does not measure the amount of reserve acidity held on the clay and organic matter particles in the soil, which will dictate how much lime is needed. Different amounts of reserve acidity will mean that two different soils at the same pH value will need different amounts of lime to raise the pH to the desired level. The reserve acidity is measured in a separate test: the buffer pH. A soil with high reserve acidity will have a low buffer pH and will require considerable lime to raise the pH.

To determine the amount of lime required to reach the target soil pH, use Table 3-7. *Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH.*

Table 3-7. Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH

	Ground limestone required – tonne/ha (based on Agricultural Index of 75)			
Buffer pH	**Target soil pH = 7.0[1]**	**Target soil pH = 6.5[2]**	**Target soil pH = 6.0[3]**	**Target soil pH = 5.5[4]**
7.0	2	2	1	1
6.9	3	2	1	1
6.8	3	2	1	1
6.7	4	2	2	1
6.6	5	3	2	1
6.5	6	3	2	1
6.4	7	4	3	2
6.3	8	5	3	2
6.2	10	6	4	2
6.1	11	7	5	2
6.0	13	9	6	3
5.9	14	10	7	4
5.8	16	12	8	4
5.7	18	13	9	5
5.6	20	15	11	6
5.5	20	17	12	8
5.4	20	19	14	9
5.3	20	20	15	10
5.2	20	20	17	11
5.1	20	20	19	13
5.0	20	20	20	15
4.9	20	20	20	16
4.8	20	20	20	18
4.7	20	20	20	20
4.6	20	20	20	20

[1] Liming to pH 7.0 is recommended only for club-root control on cole crops.
[2] Add lime if soil pH is below 6.1.
[3] Add lime if soil pH is below 5.6.
[4] Add lime if soil pH is below 5.1.

The lime requirements listed in Table 3-7 are based on the equations in Table 3-8. *Calculation of Lime Required Using Buffer pH and Target pH,* page 20, and rounded to the nearest tonne/ha. More exact requirements to adjust soil pH to 7.0 may be calculated from the equations in Table 3-8.

Table 3-8. Calculation of Lime Required Using Buffer pH and Target pH

Target soil pH	Equation*
7.0	Lime (tonne/ha) = $334.5 - 90.79\ pH_B$** $+ 6.19\ pH_B^2$
6.5	Lime (tonne/ha) = $291.6 - 80.99\ pH_B + 5.64\ pH_B^2$
6.0	Lime (tonne/ha) = $255.4 - 73.15\ pH_B + 5.26\ pH_B^2$
5.5	Lime (tonne/ha) = $37.7 - 5.75\ pH_B$

* Based on lime with an agricultural index of 75.

** pH_B = Buffer pH.

Raising the soil pH with limestone

Either calcitic or dolomitic limestone can be applied to raise soil pH. Calcitic limestone consists largely of calcium carbonate, while dolomitic limestone is a mixture of both calcium and magnesium carbonates. The carbonate in the limestone neutralizes the soil acidity.

Use dolomitic limestone on soils with a magnesium soil test of 100 ppm or less. It is particularly important to use dolomitic limestone when the level of potassium is high because high potassium levels make magnesium deficiency more likely. Either calcitic or dolomitic limestone can be used when magnesium test results are greater than 100 ppm and potassium levels are below 250 ppm.

Limestone varies in its effectiveness for raising soil pH depending on its neutralizing value and its particle size.

Neutralizing value is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. It is expressed as a percentage of the neutralizing value of pure calcium carbonate. Limestone that will neutralize 90% as much acid as pure calcium carbonate is said to have a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone, the higher its neutralizing value.

Fineness rating or particle size also affects the neutralizing value of limestone. The higher the fineness rating, the more rapidly the limestone raises the soil pH.

The agricultural index

The agricultural index combines the neutralizing value and the fineness rating of a limestone. It provides a way to compare different limestone sources. Limestone with a high agricultural index is applied at a lower rate than limestone with a low index. A limestone's agricultural index is determined by the following formula:

The agricultural index = (neutralizing value × fineness rating) ÷ 100

Limestone recommendations from the OMAFRA-accredited soil tests are based on limestone with an agricultural index of 75. When you use a limestone source with a different agricultural index, a specific rate of application may be calculated with the following equation:

$$\text{Limestone application rate from soil test} \times \frac{75}{\text{Agricultural index of the limestone source being used}} = \text{Rate of application of the limestone source being used}$$

For example, if a soil test recommends 9 tonnes/ha of limestone and the limestone source has an agricultural index of 90, the application rate should be 7.5 tonnes/ha (9 × 75/90 = 7.5 tonnes/ha).

The agricultural index does not provide information about magnesium content.

Effect of tillage depth

The lime recommendations presented in Table 3-7. *Lime Requirements to Correct Soil Acidity Based on Soil pH and Soil Buffer pH,* page 19, should raise the pH of the top 15 cm of soil to the listed target pH. If the soil is plowed to a lesser or greater depth than 15 cm, proportionately more or less lime is required to reach the same target pH. Where shallow tillage depths are used, more frequent applications of lower rates are recommended.

Lowering soil pH

On soils with pH values below 6.5, it is possible to lower the pH (make the soil more acidic) by adding sulphur or ammonium sulphate. This may be desirable for some crops (e.g., potatoes for scab control), but usually will not be suitable for rotation crops. Soil pH cannot be adjusted up or down from year to year. Ammonium sulphate should not be applied at rates of nitrogen higher than those recommended for the current crop. Blueberries require a low pH. Table 3-9. *Sulphur for Soil Acidification (kg/ha),* page 21, shows the amount of elemental sulphur required to lower the pH of various soils.

If the soil pH is above 6.5, it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulphur or ammonium sulphate required. For more information see OMAFRA Publication 611, *Soil Fertility Handbook (Soil Acidification,* page 94).

Table 3-9. Sulphur for Soil Acidification (kg/ha)

Soil type	For each 1.0 pH unit	For each 0.1 pH unit
Sand	350	35
Sandy loam	750	75
Loam	1,100	110

Nitrogen

Nitrogen is an important element for the growth and development of all plants. Nitrogen is naturally present in all soils. As soil microbes feed on crop residues and soil organic matter, they release nitrogen into the soil. As soil organic matter levels increase, so do the levels of naturally available nitrogen. Management practices which maintain and increase soil organic matter will also help to enhance soil fertility and crop productivity. Legumes, such as alfalfa and red clover, can increase soil nitrogen concentrations by capturing atmospheric nitrogen and releasing it slowly into the soil.

Visual nitrogen deficiency symptoms

Nitrogen deficiencies usually first appear on older leaves. These leaves will turn light green or yellow as nitrogen is relocated from older, less productive leaves to the newest growth. Cool growing conditions in early spring often cause plants to develop a temporary nitrogen deficiency. This is usually due to poor growing conditions, and not necessarily a lack of nitrogen in the soil.

Nitrogen and the environment

The level of nitrogen in the soil changes constantly. Processes like leaching and denitrification result in the loss of nitrogen from the soil. Denitrification occurs when the soil is waterlogged. Anaerobic microbes convert nitrate and ammonia into nitrous oxide. This gas can contribute to air pollution and is approximately 300 times more potent than carbon dioxide as a greenhouse gas.

The nitrate form of nitrogen, while being readily available to plants, moves easily in water through the soil. As a result, it has the potential to pollute groundwater and surface water.

When the amount of nitrogen supplied to the crop meets the crop's growth requirements, the risk of loss to the environment is greatly reduced. The potential for nitrogen loss is highest during the late fall and early spring. The application of nitrogen according to the crop's need reduces residual soil nitrogen at the end of the season and leaves little available for losses.

It is important to account for fertilizer, manure and other sources of nitrogen when you assess a crop's fertility requirements. Other management practices to reduce the risk of nitrate losses include:

- use of cover crops
- timing nitrogen applications close to crop nitrogen uptake
- reduction of total nitrogen applications

Sources of nitrogen

Synthetic fertilizer

The most common nitrogen fertilizer sources are outlined in Table 3-10. *Fertilizer Materials: Primary Nutrients,* on this page. Generally, all nitrogen sources are effective in providing a crop with nitrogen. Cost, crop management and ease of application will largely determine the selection of one source over another.

If nitrogen is to be applied early in the spring when soils are below 10°C, using urea may prevent leaching losses. Under these conditions, it takes 3–6 weeks for urea to convert to the plant-available ammonium and nitrate forms. As only nitrate-nitrogen is susceptible

Table 3-10. Fertilizer Materials: Primary Nutrients

Nitrogen Materials	Form	% Nitrogen (N)
Ammonium nitrate	Dry	34
Urea	Dry	46
Ammonium sulfate	Dry	20
Calcium ammonium nitrate	Dry	27
Calcium nitrate	Dry	15.5
Urea ammonium nitrate (UAN)	Liquid	28–32
Anhydrous ammonia	Liquid[1]	82
Phosphate Materials	**Form**	**% Phosphate (P_2O_5)**
Single superphosphate	Dry	20
Triple superphosphate	Dry	46
Monoammonium phosphate (11-52-0)	Dry	50–52
Diammonium phosphate (18-46-0)	Dry	46
Ammonium polyphosphate (10-34-0)	Liquid	34
Potash Materials	**Form**	**% Potash (K_2O)**
Muriate of potash	Dry	60–62
Sulfate of potash	Dry	50
Sulfate of potash magnesia (11% Mg)	Dry	22
Potassium nitrate (13-0-44)	Dry	44

[1] Liquid under pressure.

Table 3-11. Average Fertilizer Replacement Values for Different Types of Manure

Nutrient values based on average analysis for over 3,000 samples.
There are large variations in nutrient content between manures, so a manure analysis is your best guide to nutrient availability.[1]

Manure	% Average Dry Matter	Available N[2] Spring		Available[3] P_2O_5		Available[4] K_2O	
		kg/1,000 L (lb/1,000 gal)					
Liquid dairy	8.4	1.8	(18)	0.77	(7.7)	2.6	(26)
Liquid hog	3.7	2.7	(27)	1.2	(12)	1.9	(19)
Liquid poultry	10.5	5.8	(58)	2.8	(28)	3.2	(32)
		kg/tonne (lb/ton)					
Solid poultry	55.3	10.5	(21)	11	(22)	13.4	(26.8)
Solid dairy	25	1.8	(3.6)	1.5	(3)	5.2	(10.5)
Composted dairy	38.3	2.9	(5.8)	2.6	(5.2)	11.8	(23.8)
Solid beef	28.4	1.9	(3.8)	2.1	(4.3)	6.1	(12.2)
Sheep	33.8	2.9	(5.9)	2.6	(5.2)	8.3	(16.7)
Horse	37.4	1.3	(2.6)	1.4	(2.8)	4.6	(9.3)

[1] Data from manure analysis provided from Ontario Labs collected between 1992 and 2007.

[2] Nitrogen based on spring application, incorporated within 24 hr. Unincorporated manure will have less N due to ammonia losses.

[3] Phosphate from manure or biosolids is assumed to be 40% as available in the year of application as that in commercial fertilizer (another 40% of the phosphorus is available the following year).

[4] Potassium from manure is assumed to be 90% as available in the year of application as that in commercial fertilizer.

to leaching losses, early spring rain will not result in leaching where urea is used as the nitrogen source. By the time the nitrate conversion has occurred, the crop is entering its rapid growth phase and minimal downward percolation of water will make leaching less likely.

Products that modify the release of nitrogen

Slow-release fertilizers have granules that have been coated in sulphur or a polymer to control the release of the nitrogen over an extended period of time. Nitrification inhibitors are added to nitrogen fertilizers to help delay the chemical conversion of urea into the plant available forms. Depending on the weather conditions, the delayed release of these products may not necessarily coincide with peak nitrogen demand.

Manure nitrogen

In addition to nutrients and micronutrients, manure also supplies valuable organic matter that helps to build and maintain soil structure. Adjust fertilizer rates to account for the nutrients in manure.

50–60% of the nitrogen available in manure is available to the crop during the first growing season after application. The remaining organic nitrogen becomes available in small, diminishing quantities in successive years. Up to 10% of the total nitrogen in manure can be available for the following year. Where manure is applied regularly to the same field, there may be a significant amount of residual nitrogen available for a crop.

The quantities of nutrients contained in manure can vary greatly. The type of livestock, ration, bedding, added liquids and storage system all affect the final nutrient analysis. Table 3-11. *Average Fertilizer Replacement Values for Different Types of Manure*, on this page, provides the approximate amount of crop-available nitrogen in manure. A manure-analysis, available from several laboratories in Ontario, provides the most accurate assessment of the nutrients contained in a specific source of manure. Refer to Appendix C. *Accredited Soil-Testing Laboratories in Ontario*, page 289, for a list of laboratories providing this service.

Use manure responsibly

- Avoid the spread of manure on frozen or snow-covered ground.
- Avoid application when the potential for runoff (soil is wet, rain is imminent, etc.) is high.
- Tillage prior to the application of liquid manure will help to break up soil cracks and large pores, and prevent the movement of manure into field tiles or shallow groundwater.
- Inject or incorporate the manure to minimize loss of ammonia to the atmosphere and to leave more nitrogen in the soil for the crop.
- When storing manure, follow recommendations in OMAFRA Factsheet, *Temporary Field Storage of Solid Manure or Other Agricultural Source Materials*, Order No.10-039.

Manure and food safety
Fruit can become contaminated in the field if it comes into contact with pathogens that cause human illness. These pathogens may come from manure and manure-based composts. Depending on conditions, these pathogens can survive from 1 to more than 300 days after field application of fresh manure. Pathogens can be reduced to acceptable levels when manure is properly composted. Proper composting means that all parts of the manure pile must heat to 55°C for 3 days to reduce pathogen levels. Fresh or uncomposted manure should not be applied to fields where fruit or vegetable crops will be harvested within 120 days.

Legumes

Rhizobium bacteria infect the roots of legume crops. These bacteria convert atmospheric nitrogen into inorganic nitrogen. As the legume crop residue decomposes, this nitrogen becomes available for subsequent crops. When fruit crops are planted following alfalfa hay, or a legume cover crop such as red clover, the rate of fertilizer nitrogen should be decreased according to Table 3-12. *Nitrogen Contribution of Plowed Down Legumes.*

Table 3-12. Nitrogen Contribution of Plowed Down Legumes

Type of Sod	For All Crops, Deduct From N Requirement (kg N/ha)
Less than ⅓ legume	0
⅓ to ½ legume	55
½ or more legume	100
Perennial legumes seeded and plowed the same year	45[1]
Soybean and field bean residue	0

[1] Applies where the legume stand is thick and over 40 cm high.

Other organic nutrient sources

Biosolids derived from paper mill fibre have been used in orchards and vineyards to maintain soil organic matter. However, before this material can be applied to land, you must have a Certificate of Approval issued by the Ontario Ministry of the Environment (MOE) for the site. Rates depend upon the nitrogen content of the material and can be in the range of 25–30 dry tonnes/ha. However, MOE has final approval of the material and the applied rate. Any application restrictions are included as conditions on the Certificate of Approval.

Biosolids from sewage treatment plants or paper mill waste can be a useful source of nutrients and organic matter. Guidelines for their use are available from OMAFRA and MOE. A Certificate of Approval for land application is required and is available from MOE. An analysis of nutrients applied should be given by the applicator to the landowner whenever biosolids are applied. Always consult with your processor, packer or broker before applying municipal sewage biosolids on ground intended for vegetables anywhere in the rotation.

Municipal sewage biosolids must not be applied to tree fruits and grapes within three months of harvest. For small fruit (strawberries, raspberries and blueberries) application may not occur within 15 months of harvest.

Avoid fertilizer burn!
Like all inorganic fertilizers, nitrogen and potash fertilizers are salts. If a germinating seedling or young transplant comes into contact with a concentrated fertilizer band, the tender roots may become seriously damaged. For this reason, it is important to ensure that the correct fertilizer and the appropriate rate are selected for each application.

Urea is an effective, economical source of nitrogen for broadcast applications but it has a relatively high salt index. It is not suitable for use in starter fertilizers or banded applications. If low soil moisture conditions exist at the time of planting, urea burn may occur on coarse sandy-loam soils and growers should consider switching to a different nitrogen source. Anhydrous ammonia also has a relatively high salt index. It is an effective source for side-dress applications that must be injected into the soil.

Ensure that starter or transplant fertilizers contain only as much nitrogen as necessary to get the crop started. Fertilizers that contain more than half as much nitrogen as phosphate frequently contain urea and may cause crop damage.

Phosphorus

Like nitrogen, phosphorus is important to photosynthesis and the development of enzymes and protein. It also plays a major role in cell division and the creation and transport of sugars and starches.

Soil phosphorus levels across Ontario are variable. Because phosphorus tends to bind to soil particles, leaching through the soil profile is minimal. Many coarse sandy-loam soils often contain high phosphorus levels. Soils with a history of regular manure applications have high levels of phosphorus, and fruit crop yield will rarely respond to additional phosphorus fertilizer. Too much phosphorus can induce deficiencies of zinc and iron.

Visual phosphorus deficiency symptoms

Phosphorus deficiency symptoms usually develop on the older leaves first. The leaves develop a purplish-red colour that may be more noticeable on the underside of the leaves. Severe deficiencies may also cause the leaf tips to die back. Cool, wet soil conditions often induce phosphorus deficiencies. During establishment of early-planted fruit crops, use a starter fertilizer to deliver the required phosphorus directly to the root zone.

Phosphorus in the environment

Surface runoff is the main route by which phosphorus leaves the field and contaminates the environment. It can be transported in solution with runoff water or through its attachment to eroded soil particles. When this water reaches open surface water, streams can become polluted.

Avoid additional phosphorus applications to soils that are rated Rare Response (RR) or No Response (NR). If phosphorus is required to promote early season growth, use low rates applied in a band close to the roots or as a starter fertilizer.

Farmers who are required to complete a nutrient management plan must establish a permanent vegetated buffer adjacent to any surface water, with a minimum width of 3 m, prior to any nutrient application. This practice is highly recommended even in situations where it is not a requirement. The grass will help reduce erosion and act as a natural filter for runoff entering the watercourse.

Where phosphorus soil tests are greater than 30 ppm, use the Phosphorus Index to determine separation distances from surface water sources. The Phosphorus Index uses five factors, which include field slope, length of slope, soil drainage class and soil texture, to determine an appropriate rate and separation distance for phosphorus application from surface water.

For details, see OMAFRA Factsheet, *Determining the Phosphorus Index for a Field,* Order No. 05-067.

Sources of phosphorus

Mineral fertilizers

The most common phosphate fertilizer sources are outlined in Table 3-10. *Fertilizer Materials: Primary Nutrients,* page 21.

Manure

When properly applied, manure is an excellent, inexpensive phosphorus source. It also supplies the soil with valuable organic matter and micronutrients. Table 3-11. *Average Fertilizer Replacement Values for Different Types of Manure,* page 22, provides the approximate amount of crop-available phosphorus contained in manure.

Table 3-13. Phosphorus Requirements for Berries, Tree Fruits and Grapes

Soil phosphorus (ppm)*	New plantings of blueberries, strawberries, raspberries, gooseberries, currants, nursery stock	Established blueberries, strawberries, raspberries, gooseberries, currants, nursery stock	New plantings[1] of apples, peaches, pears, plums, cherries, grapes
	Phosphate (P_2O_5) required – kg/ha		
0–3	140 HR	100 HR	80 HR
4–5	130 HR	90 HR	60 HR
6–7	120 HR	80 HR	50 HR
8–9	110 HR	70 HR	40 MR
10–12	100 HR	70 HR	20 MR
13–15	90 HR	60 HR	0 LR
16–20	70 MR	50 MR	0 LR
21–25	60 MR	40 MR	0 RR
26–30	50 MR	30 MR	0 RR
31–40	40 MR	20 MR	0 RR
41–50	0 LR	0 RR	0 RR
51–60	0 RR	0 RR	0 RR
61–80	0 NR	0 NR	0 NR
80+	0 NR	0 NR	0 NR

HR, MR, LR, RR, and NR denote, respectively: high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

* 0.5 M sodium bicarbonate extract.

[1] For established tree fruits and grapes, plant analysis is used to estimate requirements.

Unlike nitrogen, the phosphorus in manure becomes available to crops over a considerable period of time. Regular manure applications may result in a buildup of soil phosphorus, which should be monitored with a soil-testing program.

Manure can pose a food safety risk on many fruit crops. Ensure at least 120 days between manure application and harvest.

Phosphorus application methods

Phosphorus is not mobile in the soil, therefore broadcasting and incorporating any required phosphorus prior to planting perennial fruit crops is crucial. Some phosphorus is often applied in a band or in transplant solution at planting to ensure good vigour of new plantings. On established perennial crops, it can be broadcast on the surface or banded near the roots. Do not rely on fertigation for phosphorus application.

Phosphorus recommendations

Use a soil test from an OMAFRA-accredited lab in conjunction with Table 3-13. *Phosphorus Requirements for Berries, Tree Fruits and Grapes,* page 24. For crop specific details see: *Apple Nutrition,* page 33, *Berry Crop Nutrition,* page 85, *Grape Nutrition,* page 137, and *Tender Fruit Nutrition,* page 161.

Potassium

Potassium is an important component of plant cells. It also influences the uptake of water by the roots and plays a role in both respiration and photosynthesis. The sugar and starch content of crops like potatoes and tomatoes may be affected by potassium levels. Most crops require equal amounts of potassium and nitrogen.

Visual potassium deficiency symptoms

Potassium deficiency usually appears on the older leaves first. It can cause yellowing or burning of the leaf margins.

Sources of potassium

Mineral fertilizers

The most common potassium sources are outlined in Table 3-10. *Fertilizer Materials: Primary Nutrients,* page 21.

Manure

Manure is an excellent, inexpensive source of potassium. It also supplies the soil with valuable organic matter and micronutrients. Table 3-11. *Average Fertilizer Replacement Values for Different Types of Manure,* page 22, provides the approximate amount of crop-available potash contained in manure.

Unlike nitrogen, the potassium found in manure can be held by the soil over a considerable period of time. Regular application of manure over time may result in a build-up of potassium which should be monitored with a soil-testing program.

Manure can pose a food safety risk on many fruit crops. Ensure at least 120 days between manure application and harvest.

Table 3-14. Potassium Requirements for Berries, Tree Fruits and Grapes

Soil potassium (ppm K)*	New or established blueberries, strawberries, raspberries, gooseberries, currants, nursery stock	New plantings of apples, peaches, pears, plums, cherries[1]	New plantings of grapes[1,2]
	Potash (K_2O) required – kg/ha		
0–15	130 HR	180 HR	270 HR
16–30	120 HR	170 HR	270 HR
31–45	110 HR	160 HR	270 HR
46–60	100 HR	140 HR	270 HR
61–80	90 HR	110 HR	270 HR
81–100	80 HR	70 MR	270 HR
101–120	70 MR	40 MR	270 HR
121–150	60 MR	20 MR	270 MR
151–180	40 MR	0 LR	270 MR
181–210	0 LR	0 LR	270 MR
211–250	0 RR	0 RR	270 LR
250+	0 NR	0 NR	270 LR

HR, MR, LR, RR, and NR denote, respectively: high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

* 1 M ammonium acetate extract.

[1] For established tree fruits and grapes, plant analysis is used to estimate requirements.

[2] Apply only every second year.

Potassium application methods

The mobility of potassium fertilizers is limited and falls between that of nitrogen and phosphorus. It is not prone to leaching losses, with the possible exception of very sandy soils low in organic matter. Potash should be broadcast and incorporated prior to planting. In drip irrigation systems up to half of the potassium requirement can be applied through fertigation after crop establishment. At least half of the potassium should be applied in the spring as a broadcast or band in the drip-line of the crop or in the herbicide strip. Potassium can be blended with nitrogen and applied in one application.

Foliar applications can be made in grapes and should be considered in dry years when soil uptake is reduced. Foliar application at veraison may improve yield of grapes.

Potassium recommendations

Use a soil test from an OMAFRA-accredited lab in conjunction with Table 3-14. *Potassium Requirements for Berries, Tree Fruits and Grapes,* on this page. For crop specific details see: *Apple Nutrition,* page 33, *Berry Crop*

Nutrition, page 85, *Grape Nutrition,* page 137, and *Tender Fruit Nutrition,* page 161.

Excessive potassium applications reduce a crop's ability to take up magnesium from the soil. Where potassium levels are high, magnesium deficiencies are more likely to occur, particularly if magnesium levels are already low.

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance in tree fruits. In apples and tender fruits, do not exceed 3 kg of potash per tree even in cases of severe deficiency.

Do not use muriate of potash (0-0-60) in blueberries, currants and gooseberries due to their sensitivity to chloride.

Calcium

Calcium is a vital component of cell walls and is involved in the metabolism and formation of the cell nucleus. Calcium pectate in the cell walls provides a physical barrier to disease entry. Calcium does not move readily within the plant.

Calcium deficiencies may cause the growing point to die. It may also cause the blossoms and buds to drop prematurely.

Calcium deficiencies rarely occur in fruit crops grown on soils with a pH of 6.0–7.5. On coarse sandy loam soil, with acidic or low pH, additional soil or foliar calcium may be required. Refer to Table 3-15. *Application Rates for Magnesium, Calcium and Micronutrients,* page 27.

Calcium-related disorders may occur in some crops, for example tip burn in strawberries, gummosis in plums, and bitter pit in some apple varieties. Several management practices will reduce the occurrence of calcium-related disorders. Avoiding over-application of nitrogen will help prevent excessive vegetative growth which can dilute the calcium in the plant. Good soil management practices ensure good root growth, which will promote both water and nutrient uptake. Timely irrigation will help keep calcium moving into the plant.

Foliar applications of calcium can be made to reduce the incidence of bitter pit in apples, gummosis in European plums, stem and bunch breakdown in certain varieties of grapes and various problems in pears. Only apply foliar calcium if a problem is anticipated because of the potential for leaf burn and premature ripening. Crop-specific recommendations can be found for apples on page 37, grapes on page 139 and plums and pears on page 164. Do not concentrate sprays or leaf burn could occur. To avoid adverse effects on fruit quality and storability, do not apply calcium formulations containing nitrogen beyond the end of July unless correcting a nitrogen deficiency. Consult OMAFRA Factsheet, *Bitter Pit Control in Apples,* Order No. 00-009.

Magnesium

Magnesium is an essential part of chlorophyll and aids in the formation of sugars, oils and fats.

In apples, magnesium deficiency can cause premature fruit drop, especially with McIntosh.

A foliar spray will correct magnesium deficiency in the current year only, and should be combined with soil application for a longer term solution.

Magnesium is mobile within the plant and therefore deficiency usually appears first on the older leaves as it translocates to the growing tissue. The leaf tissue between the veins turns yellow, while the veins remain green. Severe deficiencies will cause the leaf margins to curl.

In conjunction with an OMAFRA-accredited magnesium soil test, consult Table 3-16. *Magnesium Soil Test Ratings and Interpretations for all Fruit Crops,* page 27.

Excessive potassium applications can induce a magnesium deficiency, therefore avoid using high rates of potash on soils with a low magnesium rating.

Micronutrients

Micronutrients include boron, copper, iron, manganese, molybdenum and zinc. Plants use these elements in much smaller amounts than macronutrients like nitrogen, phosphorous, potassium, calcium and magnesium. Because such small quantities are required, routine application is generally an unnecessary expense. However, micronutrients are crucial to plant growth and deficiencies must be corrected.

Micronutrients are usually found in much lower levels in the soil than macronutrients. Soil pH, organic matter, clay and mineral content can strongly influence micronutrient availability. This makes soil tests for estimating micronutrient availability less reliable than those for the primary nutrients.

Table 3-15. Application Rates for Magnesium, Calcium and Micronutrients

A number of micronutrients are available as chelates, with various formulations and nutrient contents. Check the product labels for crop specific recommendations. The effective use rate for chelated products is the same as for other formulations.

Nutrient	Source	% Nutrient	Other nutrients	Application	
				Soil	Foliar
Calcium (Ca)	calcitic limestone	22–40%		✓	
	dolomitic limestone	16–22%	6–13% magnesium	✓	
	calcium chloride	36%	64% chloride	✓	✓
	calcium nitrate	19%	15.5% nitrogen	✓	✓
	calcium sulphate (gypsum)	23%	19% sulphur	✓	
	pelletized lime	16–40%	0–13% magnesium	✓	
Magnesium (Mg)	dolomitic limestone	6–13%	16–22% calcium	✓	
	epsom salts	9%	13% sulphur	✓	✓
	sulphate of potash magnesia	11%	22% potash K_2O 20% sulphur	✓	
Boron (B)	various granular materials	12–15%		✓	
	sodium borate	12–21%		✓	✓
	solubor	20%			✓
Copper (Cu)	copper sulphate	13–25%	6.5–12.5% sulphur	✓	
	copper chelates	5–13%			✓
Iron (Fe)	ferrous sulphate	20 %	11% sulphur		✓
	iron chelates	3–13%			✓
Manganese (Mn)	manganese sulphate	28–32%	16–18% sulphur		✓
	manganese chelates	5–12%			✓
Molybdenum (Mo)	sodium molybdate	39%			✓
Zinc (Zn)	zinc sulphate	36%	17% sulphur	✓	✓
	zinc oxysulphate	8–36%		✓	
	zinc chelate	9–14%			✓

Table 3-16. Magnesium Soil Test Ratings and Interpretation for All Fruit Crops

Soil Magnesium* (ppm Mg)	Rating	Recommendation
Below 20	HR	Magnesium (Mg) should be applied for all crops. If pH is below 6.5 apply dolomitic limestone. At higher pH values apply 30 kg soluble Mg/ha. Potash applications in excess of those recommended by soil test will increase the probability of magnesium deficiency.
20–39	MR	Magnesium is not required unless potassium soil test is above 250 ppm. If soil test K is above 250 ppm and pH is below 6.5 apply dolomitic limestone. At higher pH values with K above 250 ppm, apply 30 kg soluble Mg/ha.
40–100	LR	If limestone is required use dolomitic.
100+	NR	If limestone is required either dolomitic or calcitic may be used.

* 1 M ammonium acetate extract.
HR = high response; MR = medium response; LR = low response; NR = no response to applied nutrient.

Which to choose: soil or foliar fertilizers?

Both soil and foliar fertilizers play a role in fruit crop production. The macronutrients (nitrogen, phosphorus, potassium, calcium and magnesium) are required in relatively high amounts for crop growth. As a result, soil application is almost always the most efficient and economical method of getting these nutrients into the plant. Foliar uptake occurs through the leaf's cuticle and the stomata. The amount of nutrients that can enter the plant through these means is quite limited. Higher application rates may lead to crop injury.

Since micronutrients are required in much lower quantities, they can often be efficiently delivered through foliar applications, especially when soil conditions limit micronutrient availability. If a micronutrient deficiency is found, foliar application is the quickest way of addressing it. This can be followed with a soil application to prevent a recurrence, depending on the micronutrient and the soil pH.

Do not apply micronutrients to fruit crops unless a deficiency is identified. Apply only the deficient nutrient in sufficient quantities to correct the problem. The range between deficiency and toxicity with micronutrients can be narrow.

Use caution when you apply mixtures of several micronutrients, as crop injury may occur. Always follow the product label. Do not combine micronutrients with insecticide, fungicide or herbicide sprays unless there is information from the manufacturer of each product that indicates the mixtures are compatible. Many chelated micronutrients will consolidate in the spray tank if mixed with pesticides. Use caution when applying micronutrients through fertigation systems. Certain micronutrient blends may plug the emitters.

Foliar applied nutrient uptake can be improved through the timing of the application and the use of surfactants. Younger leaves generally have a less well-developed cuticle and are able to take up more of the nutrient. Early morning applications may favour foliar uptake, and drought stress that results in a thicker cuticle may hinder uptake. Avoid the application of foliar nutrients during the heat of the day when leaves will dry quickly. Ensure good leaf coverage, particularly on the underside.

Boron

Boron plays an important role in the structure of cell walls, fruit set and seed development as well as protein and carbohydrate metabolism.

Boron deficiency is most likely to be found on alkaline soils or sandy knolls. Symptoms vary widely between crops. Apples may exhibit internal breakdown and premature drop of highly coloured fruit. Boron toxicity may occur when sensitive crops are planted in a rotation where boron has been applied or over-applied.

There is no OMAFRA-accredited boron soil test. Some soil test reports provide a soil boron value, however, soil levels are often less than 1 ppm, making it very difficult to get an accurate measurement. To correct deficiency, fertilizer manufacturers may mix boron sources with other fertilizers to be applied. Boron can also be foliar applied for faster results. If boron is required, refer to Table 3-15. *Application Rates for Magnesium, Calcium and Micronutrients,* page 27.

Some crops are very sensitive to boron deficiencies, even at low levels. A soil pH between 5.0 and 7.0 provides the best conditions for boron uptake. Boron deficiencies are more likely to occur on soils with low organic matter and on exposed or eroded subsoils. Boron availability decreases during periods of drought.

Copper

Copper plays a role in chlorophyll production. It may also have a role in the suppression of some diseases.

Copper deficiency is rare on mineral soils, except perhaps very sandy soils.

Because soil tests for copper are unreliable, there is no OMAFRA-accredited copper soil test. Plant tissue analysis is a more useful tool. If copper is required, refer to Table 3-15. *Application Rates for Magnesium, Calcium and Micronutrients,* page 27. Copper sulphate may injure leaves. Follow label recommendations to minimize injury.

Iron

Iron is needed for chlorophyll formation, plant respiration and the formation of some proteins.

Iron deficiency, also called lime-induced chlorosis, is rare in Ontario. Symptoms appear on the young leaves first. Leaves turn yellow between the veins, but the veins will remain green except in extreme cases. Often symptoms are seen in only one area of the plant. Factors associated with iron deficiency include soils with high lime content (and therefore high pH), and gross imbalances with other micronutrients like molybdenum, copper or manganese.

An iron soil test does not correlate well with plant uptake or fertilizer response in Ontario. Consequently there is no OMAFRA-accredited iron soil test. Plant analysis is a much more reliable indicator of iron availability. Iron deficiency is easily corrected with the foliar application of iron chelates, whereas soil application is not generally effective. Refer to Table 3-15. *Application Rates for Magnesium, Calcium and Micronutrients,* page 27 and consult the manufacturer's label for information on rates and timing.

Manganese

Manganese is involved in photosynthesis and chlorophyll production. It helps activate enzymes involved in the distribution of growth regulators within the plant.

Manganese deficiency causes yellowing between veins of young leaves. Leaves gradually turn pale-green with darker green next to the veins. Manganese toxicity can occur on soils with a low pH. It causes brown spots or yellow mottled areas near leaf tips and along the leaf margins and usually develops on older leaves. Brown spots may also develop on veins, petioles and stems.

The OMAFRA-accredited manganese soil test uses a manganese availability index. This index evaluates manganese availability based on soil manganese level and soil pH.

Soil-applied manganese may be useful in acidic, sandy soils. In soils with a pH greater than 6.5, soil applied manganese will be unavailable to the plant. On alkaline soils banded applications are often more effective than broadcast. Foliar applied manganese is generally more effective where a manganese deficiency has been confirmed. If a deficiency is confirmed, apply foliar sprays when the plants are about one-third grown or sooner. Two or more sprays may be necessary at 10 day intervals.

If manganese is required, refer to Table 3-15. *Application Rates for Magnesium, Calcium and Micronutrients,* page 27.

Manganese availability is greatest at a soil pH of 5.0 to 6.5. It is important not to add more limestone than is needed to correct soil acidity. High organic matter levels decrease manganese availability. Foliar applications may be required for crops grown on muck soils.

Zinc

Zinc is important in early plant growth and in seed formation. It also plays a role in chlorophyll and carbohydrate production.

Zinc is relatively immobile within the plant. Deficiency symptoms appear first on younger leaves. Young leaves become mottled and show interveinal chlorosis, striping or banding. In advanced stages in tree fruits, small, narrow terminal leaves are arranged in whorls. This results in the typical "rosette" and "little leaf" description for zinc deficiency symptoms. Use leaf and soil analysis to test for zinc deficiency.

The OMAFRA-accredited zinc soil test is reported as a zinc index value, which estimates availability based on soil zinc level and soil pH. Zinc deficiency can be prevented by the application of zinc fertilizer to the soil at a rate of 4 kg of zinc/ha. Broadcasting up to 14 kg of zinc/ha will correct a deficiency for three years. No more than 4 kg zinc/ha should be banded. Early in the growing season, foliar sprays can be used to correct a deficiency after the symptoms have appeared. If zinc is required, refer to Table 3-15. *Application Rates for Magnesium, Calcium and Micronutrients,* page 27.

Zinc deficiencies are most often seen on sandy soils with high pH levels. Heavily eroded knolls may also have deficiency problems. Large applications of phosphorus may aggravate zinc deficiencies. Livestock manure is often an excellent source of zinc.

Where a zinc deficiency exists, check manufacturer's recommended rates and timing of applications of zinc products. If zinc is required, refer to Table 3-15. *Application Rates for Magnesium, Calcium and Micronutrients,* page 27. Foliar applications early in the growing season can be used to correct a deficiency after the symptoms have appeared.

Cover Crops

Cover crops play a major role in soil management by providing ground cover to reduce erosion and by adding organic matter to improve or maintain the soil. There is growing interest in the use of cover crops for disease and pest suppression to replace or supplement chemical controls. Cover crops have a wide variety of suitable planting dates. However, plant cover crops immediately after harvest to get the most soil improvement benefits from the cover crop investment. While broadcast application and incorporation of cover crop seed works well to establish cover crops, direct seeding or drilling will ensure faster and more even establishment.

Knowing what you want to achieve with a cover crop will help you select the best one for the job. See Table 3–17. *Selecting a Cover Crop,* page 30, and Table 3-18. *Characteristics of Cover Crops,* page 31. Cover crops can be divided into three groups based upon plant types: grasses, legumes and non-legume broadleaves.

Grasses

Grasses have fine, fibrous root systems that are well suited to holding soil in place and improving soil structure. Grass species suitable for cover crops are fast growing and relatively easy to kill (either chemically, mechanically or by winter temperatures). Grasses do not fix nitrogen from the atmosphere, but they can scavenge large quantities of residual nitrogen left in the field after harvest. Wind strips are usually created from overwintering grass cover crops.

Spring cereals

Spring cereals are well suited for late summer and early fall plantings. Under good growing conditions, spring cereals produce the greatest amount of crop biomass, and provide good ground cover. Once well established, spring cereals are relatively tolerant of frost. Do not attempt to establish spring cereals late in the fall however, as the growth will be limited.

Winter cereals

Winter cereals are highly versatile cover crops. They can be planted in summer and will tiller and thicken due to their need for a cold treatment before flowering. They can also be planted in fall for soil cover. Winter cereals generally overwinter well providing winter and spring erosion protection. These grasses can be used to create spring wind barriers or residue mulch, or they can be killed early with herbicide to minimize residue cover at planting.

Warm season grasses

Warm season grasses like sorghum and millet are best suited for planting into the warmer soils of late June, July and early August. They are very sensitive to frost. Root growth is extensive and the top growth lush. Be prepared to mow these grasses to keep stalks tender and prevent heading. Do not mow closer than 15 cm to ensure regrowth. Nitrogen may be needed to achieve optimal growth.

Legumes

Legume cover crops can fix nitrogen from the air. They then supply nitrogen to the succeeding crop, protect the soil from erosion and add organic matter. The amount of nitrogen fixed varies depending upon species, stand density and the length of growth. Generally, more top growth indicates that more nitrogen is fixed. Ontario research has suggested that legume cover crops, such as red clover, are also effective at scavenging residual nitrogen from the soil.

Nitrogen release from legumes can be inconsistent. Account for this when calculating crop fertilizer needs. Excess nitrogen release late in the season could lead to excessive vegetative growth in fruit crops.

Some legume species, such as alfalfa or red clover, have aggressive tap roots that can break up subsoil compaction, but this requires more than one season's growth.

Non-legume broadleaves

These broadleaf crops cannot fix nitrogen out of the air but they may absorb large quantities from the soil. Growth will be poor if soil nitrogen levels are low or if compaction is severe. Most of these crops are not winter-hardy, so additional control measures are not normally required. Do not allow these crops to go to seed, as the volunteer seedlings can become a significant weed problem.

New and emerging cover crops

Every year new crops are evaluated as cover crops. Often these species are from different parts of the world and may not be well adapted to Ontario growing conditions. For more information on new and well known cover crop species, see the soil management section of the OMAFRA website at *www.ontario.ca/crops* or look at the regional pages and the Cover Crop Decision Tool from the Midwest Cover Crop Council at *www.mccc.msu.edu*.

Table 3–17. Selecting a Cover Crop

Function of the Cover Crop	Best Choice for Cover Crop
Nitrogen production	• Red clover or vetch
Nitrogen scavenging	• Fall uptake – oilseed radish and other brassicas, oats • Winter/spring uptake – rye, winter wheat
Weed suppression	• Oilseed radish and other brassicas • Winter rye, sorghum sudan • Buckwheat
Nematode suppression[1]	• Mustard – Cutlass, Caliente • Sudans/sorghums – Sordan 79, Trudan 8 • Pearl millet – CFPM 101 • Marigold – Crackerjack, Creole • Oilseed radish – Adagio, Colonel
Soil structure building	• Oats, overwintered winter rye
Compaction reduction	• Alfalfa, sweet clover
Biomass return to soil	• Fall – oats, oilseed radish • Summer – millets, sorghum sudan
Erosion protection (wind or water)	• Winter rye, winter wheat • Any well established cover crop e.g. ryegrass

[1] Nematode suppression is specific to the variety of cover crop and the species of nematode.

Table 3-18. Characteristics of Cover Crops

Species	Seeding Rate kg/ha[1]	Seeding Time	Min. Germination Temp. °C (°F)	Nitrogen Fixed (F) or Scavenged (S)[2]	Overwintering Characteristics	Building Soil Structure	Weed Suppression	Nematode Rating[3] Lesion/rootknot	Growth Rate	Root Type
Grasses										
spring cereals	100–125	Mid-Aug–Sept	9 (48)	S	killed by heavy frost	good	good	+/-	very fast	fibrous
winter wheat	100–130	Sept–Oct	3 (38)	S	overwinters very well	good	good	+/nh	fast	fibrous
winter rye	100–125	Sept–Oct	1 (34)	S	overwinters very well	very good	very good	+[4]/nh	very fast	fibrous
sorghum sudan	30–50	Jun–Aug	18 (65)	S	killed by frost	good	good /fair	nh[3]/-	very fast	coarse fibrous
pearl millet	4	Jun–Aug	18 (65)	S	killed by frost	good	good/fair	nh[3]/nh[3]	fast	coarse fibrous
ryegrass	12–18	Apr–May or Aug–early Sept	4.5 (40)	S	annual, Italian often survive; perennial overwinters	very good	fair/poor	-/-	slow establishment	dense fibrous
Broadleaves – Legumes[5]										
hairy vetch	20–30	Aug	15.6 (60)	F/S	overwinters	good	fair/poor	++/+	slow establishment	tap with secondary fibrous
red clover	8–10	Mar–Apr	5 (41)	F/S	overwinters	good	fair	++/+++	slow establishment	weak tap/ fibrous
sweet clover	8–10	Mar–Apr	5.5 (42)	F/S	overwinters	good	fair	-/-	slow establishment	strong tap
soybeans	40–50	Aug	8 (46)	F/S	killed by frost	poor	good/fair	+/+	fast	tap
field peas	40-100	Jul–early Sept	5 (41)	F/S	killed by heavy frost	poor	good/fair	-/-	fast	weak tap/ fibrous
Broadleaves – Non-Legume										
buckwheat	50–60	Jun–Aug	10 (50)	S	killed by first frost	poor	very good	+++/nh	fast	weak tap/ fibrous
oilseed radish[6]	10–14	Mid-Aug–early Sept	7 (45)	S	killed by heavy frost	fair	very good	-[3]/-[3]	fast	moderate tap
other Brassicas[6] i.e. mustard, forage radish	varies with species	Mid-Aug–early Sept	5–7 (41–45)	S	species dependent, many killed by heavy frost	fair	very good	-[3]/-[3]	fast	moderate tap

Nematode Rating Codes: - = poor or non-host + = ability to host nh = non-hosts.

[1] 100 kg/ha = 90 lb/ac.

[2] Oilseed radish, buckwheat and the grasses do not fix nitrogen from the air but are scavengers of nitrogen from soil and manure applications.

[3] Varietal differences in cover crop species may affect nematode reaction.

[4] Rye whole season rating would be higher.

[5] Some diseases caused by *Pythium* and *Phytophthora* can be more severe after legume cover cropping.

[6] Oilseed radish and other Brassica crop residues can be toxic or allelopathic to subsequent crops if the following crop is planted too closely after incorporation of the cover crop. Allow the cover crop residues to break down or desiccate before planting the next crop.

4. Apples

Apple Nutrition

Test the soil one year in advance of planting apple trees, or two years before planting if pH adjustment may be necessary. The best time to thoroughly incorporate organic matter, phosphorus, potassium, and lime is before planting. These materials are required to optimize orchard productivity but do not move readily through the soil profile.

Manure for Orchards

Manure can pose a food safety risk on many fruit crops. Ensure at least 120 days between manure application and harvest.

Manure contains beneficial organic matter and many macro and micronutrients. The organic nitrogen in manure is mineralized over time, providing nitrogen in diminishing quantities for several years. Adjust additional organic and inorganic nitrogen applications accordingly. Excessive nitrogen, particularly in the second half of the growing season, can result in poor fruit colour, reduced storability, excessive growth and delayed cold-hardening of the woody tissue, which makes trees more susceptible to winter injury.

Apply no more than 7 tonnes/ha of poultry manure (20 m^3 liquid), 40 tonnes/ha of cattle manure (100 m^3 liquid), and 35 tonnes/ha of hog manure (65 m^3 liquid). Since the nutrient content of manure varies greatly, have it tested for nutrients before application (see *Manure nitrogen,* page 22). Broadcast manure at moderate rates and work into the soil in late fall or early spring before planting. Do not put manure around newly planted trees because of potential winter injury. Reduce the rate of nitrogen, phosphorus and potassium fertilizers applied to adjust for the nutrients supplied by manure. Table 3-11. *Average Fertilizer Replacement Values for Different Types of Manure,* page 22, shows the average composition of some manures and suggested reduction of fertilizer when manure is used.

For more information about food safety and the environmental impacts of manure application, see *Manure nitrogen* and *Use manure responsibly,* page 22.

pH Requirements

The pH of a soil is a measure of its acidity and affects nutrient uptake and crop performance. If the soil test report recommends a lime application to increase soil pH, add lime at recommended rates prior to planting. For details regarding rates and suggested types of lime to use, refer to *Soil pH and Liming,* page 18.

In established orchards, sample soil in the tree row every three years to ensure the pH is satisfactory. If the pH on clay loam soils drops below 5.1 and on sandy soils below 5.6, apply lime to the sod cover in the fall or before spring cultivation. The results will not show immediately because lime moves and reacts slowly in the soil.

Leaf Analysis

In established plantings, leaf analysis is the best method to determine nutrient needs. The nutrient levels in these plant tissues most accurately reflect the tree's uptake of nutrients. Soil analysis is used in conjunction with leaf analysis to determine the nutrient status of the soil. A combination of both analyses best evaluates fertilizer and lime needs. For more information on these tests, see *Plant tissue analysis,* page 16.

Table 4-1. Foliar Nutrient Sufficiency Range of Apple (Mid-Shoot Leaves Taken in Last Two Weeks of July from Mature Trees)

Variety	N*	P	K	Ca	Mg	Fe	B	Zn	Mn
	%					ppm			
Delicious, Mutsu / Crispin	2.2–2.7	0.15–0.4	1.4–2.2	0.8–1.5	0.25–0.4	25–200	20–60	15–100	20–200
Empire, Spy	2.1–2.6	0.15–0.4	1.3–2.1	0.7–1.5	0.25–0.4	25–200	20–60	15–100	20–200
McIntosh, others	2–2.5	0.15–0.4	1.2–2	0.8–1.5	0.25–0.4	25–200	20–60	15–100	20–200

* Leaf nitrogen in non-bearing trees should be 0.2% higher. Leaf nitrogen on M.9 or M.26 rootstocks should be 0.2% higher.

Many orchard conditions affect nutrient uptake. Consequently, nutrient levels vary slightly each year depending on the season. To obtain optimum growth and fruit quality, all nutrients must be present in sufficient concentrations, as indicated in Table 4-1. *Foliar Nutrient Sufficiency Range of Apple,* page 33.

For leaf analysis to be effective, sample the same trees each year and adjust the fertilizer program based on this leaf analysis. Fertilizer recommendations are adjusted to soil management practices, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered to determine the fertilizer required.

Fertilizer for Apples

Fertilizer for non-bearing apples

The best time to effectively incorporate nutrients such as potassium, phosphorous, boron and lime into the soil is prior to planting the orchard. Adequate soil test nutrient levels are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium and 1,000–5,000 ppm calcium. Table 4-2. *Phosphorus and Potassium Soil Requirements Before Planting Apples,* on this page, provides information on fertilizer rates prior to planting.

In the early years, before new trees bear their first crop, an annual early spring application of nitrogen and potash is usually required. For suggested rates, refer to Table 4-3. *Approximate Grams of Actual Nitrogen Required per Tree at Various Tree Densities and Tree Ages, Growing in Sod,* page 35 and Table 4-4. *Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod,* page 36.

On young trees, broadcast the fertilizer under the spread of the branches at least 15 cm from the trunk, since injury can result if placed too close. If the soil was prepared properly through deep cultivation and the addition of organic matter such as manure, there should be an adequate supply of other nutrients to sustain the orchard in its juvenile years.

On coarse-textured, infertile soils, it may help to use a starter solution at planting time, such as 10-52-10 or 20-20-20.

High nitrogen levels can result in excessive growth and incomplete tree hardening. Cover crops are strongly recommended to check late season growth in cultivated orchards, especially in new plantings. Cover crops such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil and will check the tree growth.

Table 4-2. Phosphorus and Potassium Soil Requirements Before Planting Apples

Soil phosphorus		Soil potassium	
New plantings of apples*		New plantings of apples*	
Soil test (ppm P)	Phosphates (P_2O_5) required kg/ha	Soil test (ppm K)	Potash (K_2O) required kg/ha
0–3	80 HR	0–15	180 HR
4–5	60 HR	16–30	170 HR
6–7	50 HR	31–45	160 HR
8–9	40 MR	46–60	140 HR
10–12	20 MR	61–80	110 HR
13–15	0 LR	81–100	70 MR
16–20	0 LR	101–120	40 MR
21–25	0 RR	121–150	20 MR
26–30	0 RR	151–180	0 LR
31–40	0 RR	181–210	0 LR
41–50	0 RR	211–250	0 RR
51–60	0 RR	250 +	0 NR
61–80	0 NR		
80 +	0 NR		

* For established apple trees, use leaf analysis to estimate requirements of Nitrogen, Phosphorus and Potassium.

HR, MR, LR, RR, and NR denote, respectively: high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

Fertilizer for bearing apples

Most bearing orchards require annual nitrogen application. Use a soil test to determine potassium requirements. These two elements significantly affect growth and productivity.

Nitrogen (N)

Nitrogen is necessary for many tree functions, including growth, fruit bud formation, fruit set and fruit size. Because of the complexity of nitrogen interactions with quality and production, the best guide for nitrogen rates is leaf analysis.

Cultivars differ in nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In some situations, if fruit tends to be small, more nitrogen may be needed. Rootstocks, spacing and pruning also influence application rates.

Tree growth, foliage colour, fruit quality such as colour and storability, nutrient balance in leaves and soil are also important considerations for determining nitrogen rates. Several forms of nitrogen are available, but ammonium nitrate (34-0-0) or calcium ammonium

Table 4-3. Approximate Grams of Actual Nitrogen Required per Tree at Various Tree Densities and Tree Ages, Growing in Sod*

		TREE DENSITY										
	ha	600	800	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400	2,600
	acre	240	320	400	480	560	640	720	800	880	960	1,040
		grams of actual nitrogen										
Tree Age (years)	1	30	30	30	30	30	30	30	30	30	30	30
	2	60	60	60	60	60	60	60	60	60	60	60
	3	90	90	90								
	4	120	120	120								
	5	150	150	150								
	6	180	170	168								
	7	206	190	186								
	8	232	210	204								
	9	258	230				**Use leaf analysis to determine nitrogen needs.**					
	10	284	250									
	11	310										
	12	336										
	13 or older											

Reduce nitrogen rate by half if orchard is cultivated without sod between tree rows.

Do not exceed 200 kg of actual nitrogen per ha per season regardless of number of trees per ha.

* These are approximate values. The exact amount of nitrogen to apply is a function of soil nitrogen level, cultivar, rootstock, soil moisture, etc. The best way to determine nitrogen requirements is with regular leaf analysis.

nitrate (27-0-0) are the most economical. If you use blended fertilizers, request ammonium nitrate as the nitrogen source. Do not apply urea (46-0-0) to orchards with sod between the rows because urea must be incorporated to prevent loss of ammonia nitrogen to the air.

Nitrogen rates

Given the variety of orchard systems, rootstocks, cultivars and soil types, the exact amount of nitrogen to apply varies. Use leaf analysis to evaluate the nitrogen needs of specific plantings. Table 4-3. *Approximate Grams of Actual Nitrogen Required per Tree at Various Tree Densities and Tree Ages, Growing in Sod*, on this page, is an estimate of possible nitrogen requirements. When the tree canopy covers the available space, nitrogen fertilizer requirements level out and do not increase indefinitely with tree age. Orchards grown under clean cultivation require about half the nitrogen required by orchards grown in sod.

- If late winter or early spring pruning is to be severe, reduce or eliminate nitrogen application for that year.
- Do not apply excessive amounts of nitrogen. Late or excessive applications result in poor fruit colour and quality. Available nitrogen late in the season may affect hardening off and increase the possibility of winter injury.
- In cultivated orchards, use cover crops to help lower the nitrogen level in the latter part of the season. Cover crops such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil and limit tree growth.
- In orchards with herbicide-treated strips under trees, allow some weed growth late in the season. Weeds will take up extra nitrogen, which helps harden off trees and improve fruit quality.
- For all apple cultivars, do not exceed the maximum rates of 200 kg actual nitrogen per ha per year, even in the case of a severe deficiency.

Nitrogen placement and timing

Apply nitrogen fertilizer in early April. In cultivated orchards, broadcast nitrogen under the tree canopy. In orchards with sod between the rows, place the nitrogen in a band under the drip line or in the herbicide strip.

Table 4-4. Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod*

		TREE DENSITY											
	ha	**< 500**	**600**	**800**	**1,000**	**1,200**	**1,400**	**1,600**	**1,800**	**2,000**	**2,200**	**2,400**	**2,600**
	acre	**< 200**	**240**	**320**	**400**	**480**	**560**	**640**	**720**	**800**	**880**	**960**	**1,040**
		grams of muriate of potash											
Tree Age (years)	1	80	80	80	80	80	80	80	80	80	80	80	80
	2	80	80	80	80	80	80	80	80	80	80	80	80
	3	80	80	80	80	**Use leaf analysis to determine potash needs.**							
	4	80	80	80	80								
	5	80	80	80	80								
	6	80	80	80	80								
	7	80	70	63	52								
	8	80	70	63	52								
	9	80	70	63	52								
	10	80	70	63	52								

Do not exceed 800 kg of 0-0-60 per ha per season regardless of number of trees per ha.

* These are approximate values. The exact amount of muriate of potash to apply is a function of soil potassium level, cultivar, rootstock, soil moisture, etc. The best way to determine potash requirements is by leaf analysis.

Foliar application of nitrogen

Foliar applications of urea (46% nitrogen) have been used successfully on apples when weather or crop conditions resulted in the need for additional nitrogen at a critical time.

On apples, use no more than 2.7 kg N/1,000 L water (6 kg urea) and apply at least 2,000 L/ha starting 7–10 days after petal fall. Make no more than three applications, about 10 days apart. Do not apply later than the end of July or fruit quality and winter survival of the tree could be adversely affected.

Phosphorus (P)

Phosphorus is not required in large amounts by apple trees. With a few exceptions, the level of phosphorus in Ontario soils is generally adequate. Phosphorus may be required for sod or cover crop maintenance. A soil test is the best way to determine if this nutrient needs to be added to the sod cover. If indicated, apply phosphorus before planting so it can be thoroughly incorporated in the soil. Phosphorus soil test values between 12 and 20 ppm are considered adequate for tree establishment and fruit production.

Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance. Because an excess of potassium can lead to a deficiency of magnesium (Mg), avoid unnecessary potassium applications. Potassium soil test values between 120 and 150 ppm are considered adequate when planting fruit trees. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available, use the approximate rates in Table 4-4. *Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod,* on this page.

Apply no more than 3 kg of K_2O (5 kg of muriate of potash) per mature standard apple tree in a year, regardless of how severe the potassium deficiency. When fertilizing trees on dwarfing rootstocks, consult Table 4-4. *Approximate Grams of Muriate of Potash Required per 2.5 cm of Trunk Diameter at Various Tree Densities, Grown in Sod,* on this page, for approximate rates of muriate of potash to apply. When the tree canopy has covered the space available, potassium fertilizer requirements level out and do not increase indefinitely with tree age. Leaf analysis is the most reliable guide to determine potassium requirements.

Placement and timing

The best time to apply potassium, either separately or combined with nitrogen, is the spring. While some growers prefer the fall because of time constraints in the spring, leaching over winter may cause potassium loss. For this reason apply in spring if possible.

In orchards with sod between the rows, apply potash in a band around the drip line or in the herbicide strip.

Table 4-5. Calcium Foliar Sprays

Timing	Product	Rate	Notes
Four sprays spaced two weeks apart beginning in mid-July. Additional sprays can be applied up to harvest.	Calcium chloride* (77% flakes)	5 kg/1,000 L water	Not recommended on McIntosh or Idared. Wet tree to point of runoff. Pesticides may not be compatible – check label.
	Calcium nitrate	9 kg/1,000 L water	Use only if leaf nitrogen is low. Do not apply later than the end of July. For pesticide compatibility consult labels.
	Other formulations including chelates	Consult label	

* When using calcium chloride, mix required calcium in a pail of water first to be sure all product is dissolved before adding slurry to spray tank.

Calcium (Ca)

A lack of calcium is associated with fruit problems such as bitter pit of apple.

Foliar application of calcium to apples reduces the incidence of bitter pit and cork spot. Where these disorders have been a problem, apply four foliar sprays two weeks apart, beginning in mid-July. See Table 4-5. *Calcium Foliar Sprays,* on this page. Where more calcium is required, make additional applications by either beginning earlier around mid-June or by continuing until harvest.

Calcium advances fruit maturity, so be prepared to adjust the timing of harvest as a result of calcium foliar sprays.

Some formulations of calcium chloride ($CaCl_2$), if applied too close to harvest, have resulted in poor fruit finish. Calcium sprays must contact the fruit for uptake to be effective. Therefore, water volumes capable of wetting the entire tree are required. High concentrations of calcium can cause foliar burn.

Do not concentrate $CaCl_2$ (77% flakes) beyond 5 kg/1,000 L of water in mid-July and no more than 7 kg/1,000 L for applications at or beyond mid-August. Do not apply calcium formulations that contain nitrogen after the end of July or fruit quality and storability may suffer. For all formulations, consult the label directions for concentrations and compatibility with pesticides. The product used is not as important as the total amount of actual or elemental calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results, up to 12 kg/ha of actual calcium is often required in a total of four or more sprays.

Calcium sprays may cause foliage and/or fruit injury if applied when low temperature and wet weather delay drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

Recent studies with calcium sprays on McIntosh failed to show an advantage in fruit firmness and storage quality when fruit was stored in regular controlled atmosphere storage for five and a half months. Limit applications of calcium to fruit that has a known deficiency and/or is prone to bitter pit or cork spot. For more information on calcium disorders, consult OMAFRA Factsheet, *Bitter Pit Control in Apples*, Order No. 00-009.

Magnesium (Mg)

Magnesium soil test values between 100 and 250 ppm are considered adequate when you plant fruit trees. Magnesium deficiency has become more evident in orchards, particularly where high rates of potash have been used. Magnesium deficiency can lead to premature drop of fruit at harvest, especially with McIntosh. As magnesium is a part of the chlorophyll molecule, magnesium deficient trees have older leaves that are pale in colour. Leaf analysis is the best way to evaluate magnesium requirements.

Foliar sprays of magnesium effectively correct this deficiency only for the year of application. See Table 4-6. *Magnesium Foliar Sprays,* page 38.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate, so apply magnesium sulfate separately. Check manufacturer's label about mixing magnesium chelates with pesticides. Use chelates recommended for foliar spays.

For long-term corrections, soil applications of magnesium are required; however, crop response is not usually immediate. On some soil types a single, early spring application of soil-applied magnesium is not effective. A second or third application the next spring may be needed before the magnesium level in the tree improves. To avoid early fruit drop in this waiting period, apply foliar magnesium sprays for the first two years, in addition to soil applications.

Table 4-6. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
Three sprays spaced two weeks apart beginning at calyx	Magnesium sulfate (Epsom salts)	20 kg/1,000 L water	Wet tree to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

Use dolomitic limestone to supply magnesium and raise the soil pH on acidic soils.

Where lime is not required, apply sulphate of potash magnesia at 5–7 kg per mature standard tree or 3–4 kg per mature dwarf tree. This is a granular fertilizer that contains approximately 21% potash and 11% magnesium. Apply this material in early spring in a band under the tree drip line. It contains potassium (K) and the rate of application depends on potash needs. Other sources of magnesium also work well as a soil application. If magnesium is blended with the fertilizer, apply at least 80 kg of available magnesium per ha when the fertilizer is spread.

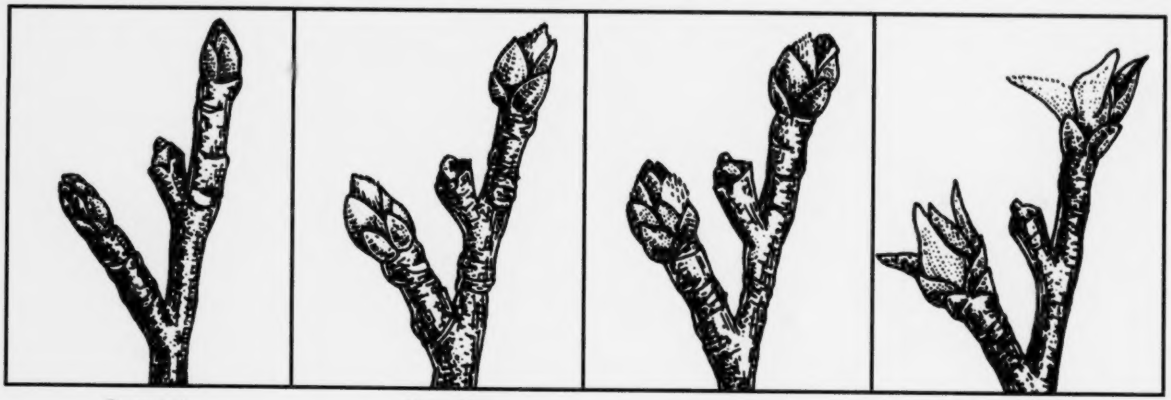
Warning: Apply nutrient sprays according to recommended rates on the product label. Do not spray at temperatures above 25°C.

Micronutrients for Apples

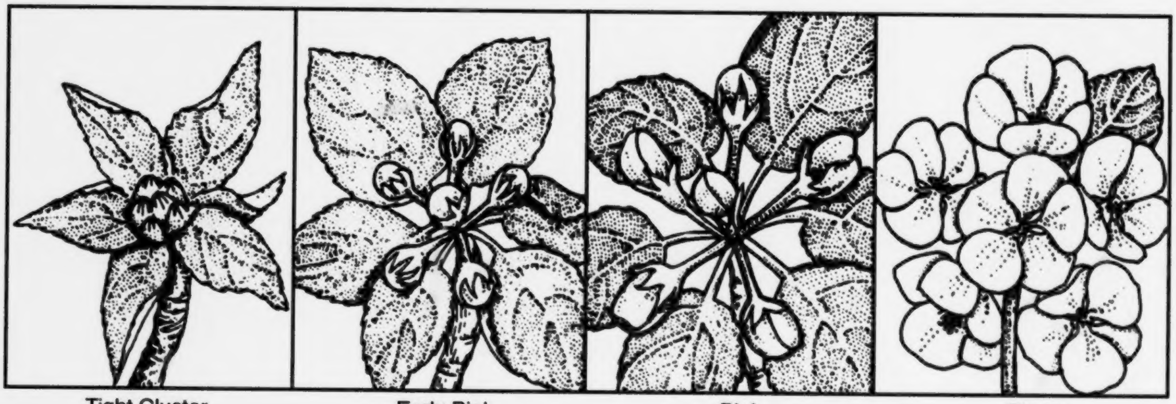
Deficiencies of micronutrients or trace elements are not widespread in Ontario apple plantings. Boron deficiency is perhaps the most common. Deficiencies of zinc, manganese and iron appear occasionally, particularly in alkaline or high pH soils.

The desirable range for micronutrients is very small. More damage is possible with excess amounts than with deficiencies. Do not apply micronutrients to apples except when deficiency is confirmed by leaf analysis or visible symptoms. Apply only the nutrient that is deficient in sufficient quantities to correct the problem. For more information on micronutrients in apples, see *Micronutrients,* page 26.

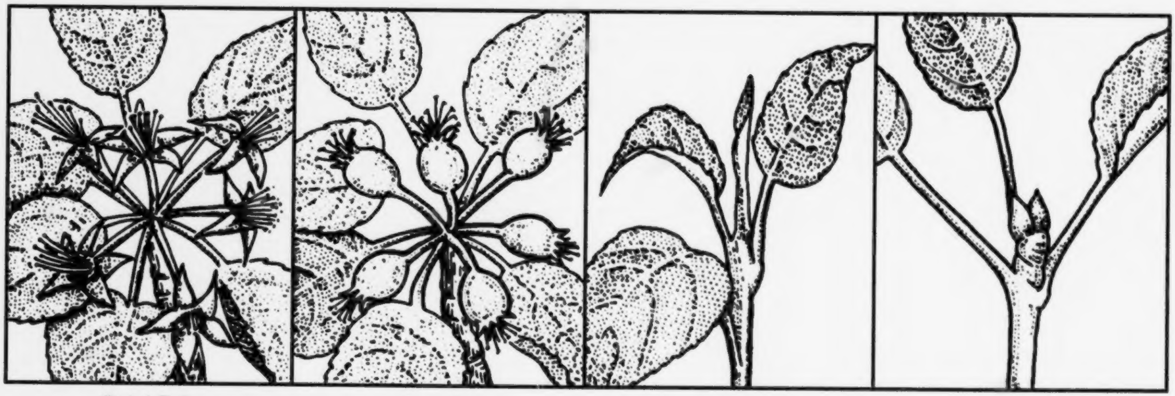
Figure 4-1. Apple Growth Stages



Dormant Silver Tip Green Tip Half-Inch Green



Tight Cluster Early Pink Pink Bloom



Petal Fall Fruit Set Terminal Growth Regrowth

Apple Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For information on identifying pests and monitoring apple orchards, refer to OMAFRA Publication 310, *Integrated Pest Management for Apples* or Ontario CropIPM: Integrated Pest Management Training available on the OMAFRA website *www.ontario.ca/cropIPM* or in OMAFRA Publication AF141 (CD format).

Products are listed according to insecticide and fungicide group. Use products from different groups to prevent the development of pest resistance. For resistance management, refer to *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 4-7. *Products Used on Apples,* page 57.

Diseases and Insects	Products	Rate	Comments
Dormant			
San Jose scale European fruit scale Lecanium scale	• Superior 70 Oil • Purespray Green Spray Oil 13 E	20 L of oil/1,000 L water 20 L of oil/1,000 L water	Oil may cause bark injury on Red Delicious, Empire and Mutsu/Crispin. Apply full rate of oil in 2,000–3,000 L of water per ha. On large standard trees, use 90 L of oil in 4,500 L of water per ha. Do not use oil within 48 hours of freezing temperatures or within 14 days of Captan or Maestro or any other product containing sulphur. Use a maximum of one application per season.
Green tip to half-inch green			
Apple scab protectants	• Manzate Pro-stick or Dithane DG or Penncozeb 75 DF • Polyram DF • Supra Captan 80 WDG or Maestro 80 DF • Vangard 75 WG • Scala SC • Allegro 500 F	6 kg/ha 6 kg/ha 2 kg/1,000 L water 6 kg/ha 3.75 kg/ha 3.75 kg/ha 370 g/ha 1 L/ha 0.75–1 L/ha	Apply fungicides before spore release and keep growing leaves covered. See *Apple scab,* page 64 for information on infection periods. Alternate materials from different groups. **Vangard, Scala:** These products do not control other foliar or fruit diseases. Use once then rotate to a different group. Use a maximum of two applications per season, prebloom only. **Serenade MAX:** Provides suppression of apple scab. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX),* page 242.
Powdery mildew	Use one of the fungicides recommended at **Tight cluster to pink.**		If powdery mildew was a problem in previous years, then a fungicide is necessary at this stage.
Half-inch green to tight cluster			
European red mite	• Superior 70 Oil • Purespray Green Spray Oil 13 E	20 L of oil/1,000 L water 20 L of oil/1,000 L water	Oil may cause bark injury on Red Delicious, Empire and Mutsu/Crispin. Apply before overwintering eggs hatch. Usually the best timing is between **Half-inch green to tight cluster** when temperatures are getting warmer. Do not apply full rate of oil more than once per season. Apply oil in 2,000–3,000 L of water per ha. On large standard trees, use 90 L of oil in 4,500 L of water per ha. Do not use oil within 14 days of spraying Captan or Maestro or any other product containing sulphur. Do not apply during periods of drought, when plants exhibit moisture stress.
Rosy apple aphid	• Assail 70 WP • Actara 25 WG • Calypso 480 SC • Movento 240 SC • Beleaf 50 SG	120 g/ha 160 g/ha 145–290 mL/ha 365 mL/ha 160 g/ha	Spray if 20 or more clusters in a 100-cluster sample are infested. **Assail, Actara, Calypso (neonicotinoids):** Use a maximum of two neonicotinoid applications per season. Repeated use of some neonicotinoids may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57. **Actara:** Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply during bloom, and wait at least 5 days after treatment before placing beehives in or near treated fields. **Movento:** Has slow activity; control may not be apparent for 2–3 weeks. Under high pest pressure, a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant /additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur.

Diseases and Insects	Products	Rate	Comments
Scab	• Manzate Pro-stick or Dithane DG or Penncozeb 75 DF	6 kg/ha 6 kg/ha 2 kg/1,000 L water	Resistance to Group 3 and Group 11 fungicides has been confirmed in Ontario. Check the status of these products before using them in your orchard. See *Managing resistance to fungicides,* page 254. The following products are compatible with oil: • Polyram DF • Dithane DG • Manzate Pro-Stick When mixing fungicides with oil, add fungicide to tank when ¼ to ½ full of water and mix thoroughly. Add oil last when tank is at least ½ full of water. Do not use oil within 14 days of Captan or Maestro. **Sovran, Flint, Pristine, Nova, Nustar, Inspire:** Do not use earlier than **Tight cluster**. See Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action,* page 257. After last application, tissue is protected from infection for 5–8 days. In conditions of rapid growth, shorten intervals between applications. Do not use if apple scab is present. Use of these products as eradicants may result in the development of fungicide resistance. **Pristine:** Use the higher rate and a shorter interval during periods of rapid growth or when disease pressure is high. **Vangard, Scala:** These products do not control other foliar or fruit diseases. Use once then rotate to a different group. Use a maximum of two applications per season, prebloom only. Do not apply if apple scab is present. **Serenade MAX:** Provides suppression of apple scab. See *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)* page 242.
	• Polyram DF	6 kg/ha	
	• Supra Captan 80 WDG or Maestro 80 DF	3.75 kg/ha 3.75 kg/ha	
	• Sovran	240 g/ha	
	• Flint 50 WG	140 g/ha	
	• Pristine WG	1–1.2 kg/ha	
	• Nova 40 W plus Dithane DG	340 g/ha 3 kg /ha	
	• Nova 40 W plus Polyram DF	340 g /ha 3 kg/ha	
	• Nova 40 W plus Maestro 80 DF	340 g /ha 1.9 kg/ha	
	• Nustar plus Manzate Pro-stick	100 g/ha 3 kg/ha	
	• Inspire plus Dithane DG or Manzate Pro-stick or Penncozeb 75 DF	292 mL/ha 6 kg/ha 6 kg/ha 2 kg/1,000 L water	
	• Inspire plus Maestro 80 DF or Supra Captan 80 WDG	292 mL/ha 3.75 kg/ha 3.75 kg/ha	
	• Inspire plus Vangard 75 WG	292 mL/ha 370 g/ha	
	• Vangard 75 WG	370 g/ha	
	• Scala SC	1 L/ha	
	• Allegro 500 F	0.75–1 L/ha	
Powdery mildew	Use one of the products recommended at **Tight cluster to pink**.		
Oriental fruit moth (OFM)	• Isomate-M100 • Isomate-M Rosso	250 dispensers/ha 500 dispensers/ha	Management of OFM is only necessary in orchards where there is a history of damage. Place dispensers in orchards in late April before flight begins. Initial OFM population must be low for good results. Apply to square or rectangular orchard blocks at least 4 ha in size. For more information, see *Using mating disruption to control oriental fruit moth,* page 249. **Isomate-M100:** Dispensers release pheromone for up to 90 days. Make a second application 75–80 days after initial application for late season varieties. **Isomate-M Rosso:** Provides control for up to 120 days. Outbreaks of other pests may occur when insecticides are not used for OFM. Monitoring is extremely important where using mating disruption. Insecticides may be needed in late varieties where high OFM populations exist.

Diseases and Insects	Products	Rate	Comments
Tight cluster to pink			
Tentiform leafminer	• Assail 70 WP	80 g/ha	Apply if there are three or more eggs per spur or one or more sap-feeders per leaf. **Assail, Actara, Calypso (neonicotinoids):** Apply when population is mainly in the sap-feeder stage. Use a maximum of two neonicotinoid applications per season. Repeated use of some neonicotinoids may result in mite outbreaks. See Table 4-7. *Products Used on Apples*, page 57. **Actara:** Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply during bloom, and wait at least 5 days after treatment before placing beehives in or near treated fields. **Intrepid, Confirm:** Apply at first egg hatch. Confirm provides suppression rather than control of leafminer populations. Continue monitoring after application. **Altacor, Delegate:** Apply when population is mainly in the sap-feeder stage. **Pounce, Ambush, Perm-Up, Ripcord, Up-Cyde, Decis, Matador, Silencer (pyrethroids):** Apply at first egg hatch. Pyrethroids are highly toxic to beneficial insects, and may lead to outbreaks of European red mite. Use a maximum of one application per season.
	• Actara 25 WG	315 g/ha	
	• Calypso 480 SC	145 mL/ha	
	• Intrepid 240 F	500 mL/ha	
	• Confirm 240 F	1 L/ha	
	• Altacor	215 g/ha	
	• Delegate WG	420 g/ha	
	• Pounce 384 EC	520 mL/ha	
	or Perm-Up	520 mL/ha	
	or Ambush 500 EC	400 mL/ha	
	• Decis 5 EC	250 mL/ha	
	• Ripcord 400 EC	250 mL/ha	
	or Up-Cyde 2.5 EC	400 mL/ha	
	• Matador 120 EC	83 mL/ha	
	or Silencer 120 EC	83 mL/ha	
Scab	Use one of the fungicides recommended at **Half-inch green to tight cluster.**		
Powdery mildew	• Nova 40 W	340 g/ha	Spray susceptible varieties. If powdery mildew was prevalent the previous year, apply fungicides beginning at **Green tip.** Otherwise, begin application at **Tight cluster** and continue to **First summer spray.** Additional sprays beyond **First summer spray** may be needed on susceptible varieties or if disease pressure is severe. **Nova, Nustar:** These products are weak on fruit scab and should be tank-mixed with a protectant fungicide. See options for apple scab control at **Half-inch green to tight cluster.** **Flint:** For powdery mildew control, use 210 g/ha during pink to bloom stage. **Pristine:** Use the higher rate and a shorter interval during periods of rapid growth or when disease pressure is high. **Microscopic Sulphur, Kumulus, Microthiol Disperss:** Do not use on Delicious because these products can cause an increase in red mite and scale insect populations. **Purespray Green Spray Oil 13E, Inspire, Serenade Max:** Provide suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. **Purespray Green Spray Oil 13E:** Summer oils can cause crop injury, depending on rate, cultivar, weather conditions, and recent pesticide applications. Do not use within 14 days of Captan or Maestro application. Read the label carefully for other precautions. See notes on *Mineral oil (Purespray Green Spray Oil 13E)*, page 252. **Serenade Max:** See *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
	• Nustar	200 g/ha	
	• Sovran	240 g/ha	
	• Flint 50 WG	140–210 g/ha	
	• Pristine WG	1–1.2 kg/ha	
	• Microscopic Sulphur	6.5 kg/1,000 L water	
	• Kumulus DF	22.5 kg/ha	
	• Microthiol Disperss	22.5 kg/ha	
Rust	• Ferbam 76 WDG	1.25–2 kg/1,000 L water	Spray if the alternate host, Eastern red cedar is nearby. Fungicides should be applied to prevent infections. Include in each spray up to and including **First summer spray.** **Ferbam:** May cause russeting on Golden Delicious and other sensitive varieties. **Nova, Inspire:** Should be used with a protectant fungicide. See options for apple scab control at **Half-inch green to tight cluster.**
	• Polyram DF	6 kg/ha	
	• Dithane DG	6 kg/ha	
	or Penncozeb 75 DF	2 kg/1,000 L water	
	• Nova 40 W	340 g/ha	
	• Inspire	292 mL/ha	
	• Flint 50 WG	140 g/ha	

Diseases and Insects	**Products**	**Rate**	**Comments**
Plant bugs	• Ripcord 400 EC • Matador 120 EC or Silencer 120 EC • Ambush 500 EC	250 mL/ha 104 mL/ha 104 mL/ha 400 mL/ha	Apply only in orchards where monitoring indicates plant bugs are active. **Ripcord, Matador, Silencer, Ambush (pyrethroids):** Are highly toxic to beneficial insects, and may lead to mite outbreaks.
Codling moth (CM) and Oriental fruit moth (OFM)	• Isomate-CM/OFM TT	500 dispensers/ha	Reduces mating of CM and OFM. Use mating disruption only if initial pest populations are low. Apply to square or rectangular orchard blocks at least 4 ha in size. Place pheromone traps for monitoring CM in orchard by bloom. Apply dispensers no later than petal fall, before first CM flight. Dispensers last for up to 150 days for CM and up to 90 days for OFM. Apply dispensers on lateral branches in upper third of tree canopy. Double the rate of dispensers at edges of orchards. Most orchards will require insecticides for one or both CM generations to prevent fruit damage. Insecticides for OFM may be needed in late varieties where high OFM populations exist. Outbreaks of other pests may occur when insecticides are not used for CM. Pest monitoring is extremely important where using mating disruption. See *Using mating disruption to control codling moth and oriental fruit moth (Isomate-CM/OFM TT),* page 249.
Spring-feeding caterpillars	• Imidan 50 WP • Zolone Flo	3.75 kg/ha 2 L/ha	Apply if there are 12 to 15 larvae in 100 terminals. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012.
Pink			
Scab	Use one of the fungicides recommended at **Half-inch green to tight cluster.**		
Black rot	• Supra Captan 80 WDG or Maestro 80 DF	3.75 kg/ha 3.75 kg/ha	Apply fungicides preventatively to susceptible varieties in orchards with a history of black rot infections. Do not use oil within 14 days of Maestro or Captan.
European red mite	• Carzol SP Instapak	1.1 kg/ha	Miticides are most effective when used alone. **Carzol**: Harsh on beneficial mite species and bees.
Rosy apple aphid	• Assail 70 WP • Calypso 480 SC • Movento 240 SC • Zolone Flo • Beleaf 50 SG	120 g/ha 145–290 mL/ha 365 mL/ha 2 L/ha 160 g/ha	Pink is the preferred time for control. Spray if 20 or more clusters in a 100-cluster sample are infested. See Table 13-3. *Relative Toxicity of Pesticides to Honeybees,* page 268. **Assail, Calypso (neonicotinoid):** Some neonicotinoids are toxic to bees. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57. **Movento:** Has slow activity; control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant / additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012.
European apple sawfly	• Assail 70 WP • Calypso 480 SC	240 g/ha 290 mL/ha	Apply where there has been a history of damage. Use 3-D white sticky traps to monitor for sawfly adults. Re-apply at petal fall if monitoring indicates populations have reached economic thresholds. **Assail, Calypso (neonicotinoids):** Use a maximum of two applications per season. Repeated use of products in this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57.

Diseases and Insects	Products	Rate	Comments
Bloom			
	DO NOT APPLY INSECTICIDES WHILE APPLE TREES ARE IN BLOOM. SEE *BEE POISONING* ON PAGE 267.		
Scab	• Manzate Pro-stick or Dithane DG or Penncozeb 75 DF • Polyram DF • Supra Captan 80 WDG or Maestro 80 DF • Sovran • Flint 50 WG • Pristine WG • Nova 40 W plus Dithane DG • Nova 40 W plus Polyram DF • Nova 40 W plus Maestro 80 DF • Nustar plus Manzate Pro-stick • Inspire plus Dithane DG or Manzate Pro-stick or Penncozeb 75 DF • Inspire plus Maestro 80DF or Supra Captan 80WDG • Allegro 500 F	6 kg/ha 6 kg/ha 2 kg/1,000 L water 6 kg/ha 3.75 kg/ha 3.75 kg/ha 240 g/ha 140 g/ha 1–1.2 kg/ha 340 g/ha 3 kg/ha 340 g/ha 3 kg/ha 340 g/ha 1.9 kg/ha 100 g/ha 3 kg/ha 292 mL/ha 6 kg/ha 6 kg/ha 2 kg/1,000 L water 292 mL/ha 3.75 kg/ha 3.75 kg/ha 0.75–1 L/ha	Resistance to Group 3 and Group 11 fungicides has been confirmed in Ontario. Check the status of these products before using them in your orchard. See *Managing resistance to fungicides,* page 254. **Sovran, Flint, Pristine, Nova, Nustar, Inspire:** Do not use earlier than **Tight cluster.** See Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action,* page 257. After last application of Sovran, Flint, Nova or Nustar, tissue is protected from infection for 5–8 days. In conditions of rapid growth, shorten intervals between applications. Check label for details. Do not use Nova, Nustar, Inspire, Sovran, Flint, or Pristine if apple scab is present. Use of these products as eradicants may result in the development of fungicide resistance. **Nova, Nustar, Inspire (DMI fungicides):** Weak on fruit scab, so do not start a DMI program after bloom. **Pristine:** Use the higher rate and a shorter interval during periods of rapid growth or when disease pressure is high. **Serenade MAX:** Provides suppression of apple scab. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX),* page 242.
Fire blight	• Streptomycin 17	600 g/1,000 L water	Models to time fire blight sprays are available. See information on MaryBlyt or Cougar Blight in OMAFRA Publication 310, *Integrated Pest Management for Apples.* Otherwise, apply sprays if temperatures over 18°C are accompanied by high humidity (over 69%), heavy dews or rainfall. Spray susceptible varieties beginning at first bloom until petal fall. Streptomycin is most effective when applied in high volumes of water prior to an infection period. Use alone for best results. Streptomycin 17 is UV light sensitive and is only effective for 2–3 days. Re-application is needed after 2–3 days if warm, wet conditions (above 18°C) are forecast. Use a maximum of three applications per season. **Biopesticides** are available for fire blight suppression. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control, and notes on Serenade MAX, *Bacillus subtilis (Serenade ASO, Serenade MAX),* page 242 and *Pantoea agglomerans* (Bloomtime Biological FD), page 243.
Late Bloom/Early Petal Fall			
Fire blight (Suppression of shoot blight stage)	• Apogee	1.35 kg/ha	**Apogee:** Reduces vegetative growth, making trees less susceptible to fire blight infections of shoots. Apogee has no impact on blossom blight or the fire blight bacteria. Apply in late bloom or early petal fall when shoots are 2.5–5.5 cm long. Accurate timing is critical. Apogee will help suppress fire blight infections from this point on. Re-apply spray 14–21 days later. In plantings with low vigour, a reduction in shoot growth caused by the high rate of Apogee for fire blight suppression may be undesirable. For more information on the use of Apogee refer to *Vegetative growth control in apples,* page 81.

Diseases and Insects	Products	Rate	Comments
Petal fall (Calyx) when most petals have fallen Some products control more than one pest. See Table 4-8. *Activity of Petal Fall Insecticides Against Orchard Pests,* page 59.			
Scab	Use one of the fungicides recommended at **Bloom.**		
Black rot	Use one of the fungicides recommended at **Pink.**		
Tentiform leafminer	• Agri-Mek 1.9% EC • Admire 240 F or Alias 240 SC • Assail 70 WP • Actara 25 WG • Calypso 480 SC • Clutch 50 WDG • Altacor • Delegate WG • Pounce 384 EC or Perm-Up or Ambush 500 EC • Decis 5 EC • Ripcord 400 EC or Up-Cyde 2.5 EC • Matador 120 EC or Silencer 120 EC	750 mL/ha 380 mL/ha 380 mL/ha 80 g/ha 315 g/ha 145 mL/ha 140–210 g/ha 215 g/ha 420 g/ha 520 mL/ha 520 mL/ha 400 mL/ha 250 mL/ha 250 mL/ha 400 mL/ha 83 mL/ha 83 mL/ha	Apply after egg hatch begins, if there is one or more sap-feeding mines per leaf. **Agri-Mek:** Do not apply later than 21 days after petal fall. Apply with 10 L of Superior 70 Oil and a minimum of 1,000 L of water per ha. Agri-Mek plus oil may cause russeting on Golden Delicious and other light-skinned cultivars. Do not tank mix Agri-Mek plus oil with other products and do not use within 14 days of Captan or Maestro application. **Admire, Alias, Assail, Actara, Calypso, Clutch (neonicotinoids):** Apply these insecticides when population is mainly in the sap-feeder stage. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57. **Actara:** Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply during bloom and remove bee hives from the orchard before application. **Altacor, Delegate:** Apply when population is mainly in the sap-feeder stage. **Pounce, Ambush, Perm-Up, Ripcord, Up-Cyde, Decis, Matador, Silencer (pyrethroids):** In years where leafminer egg hatch is delayed, a pyrethroid can be applied at petal fall when first sap-feeding mine is detected. Pyrethroids are highly toxic to beneficial insects, and may lead to outbreaks of European red mite. Use a maximum of one pyrethroid application per season. See Table 13-3. *Relative Toxicity of Pesticides to Honeybees,* page 268.
Rosy apple aphid	• Admire 240 F or Alias 240 SC • Assail 70 WP • Actara 25 WG • Calypso 480 SC • Clutch 50 WDG • Movento 240 SC • Zolone Flo • Beleaf 50 SG	230 mL/ha 230 mL/ha 120 g/ha 160 g/ha 145–290 mL/ha 140–210 g/ha 365 mL/ha 2 L/ha 160 g/ha	Spray if 20 or more clusters in a 100-cluster sample are infested. **Admire, Alias, Assail, Actara, Calypso, Clutch (neonicotinoids):** Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57. **Actara:** Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply during bloom and remove bee hives from the orchard before application. **Movento:** Has slow activity; control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant / additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012.
Mullein leaf bug	• Admire 240 F or Alias 240 SC • Assail 70 WP • Actara 25 WG • Calypso 480 SC • Diazinon 50 WSP	380 mL/ha 380 mL/ha 80–160 g/ha 315 g/ha 290 mL/ha 3.25 kg/ha	Apply controls where 7–9 nymphs are caught per 25 taps. **Admire, Alias, Assail, Actara, Calypso (neonicotinoids):** Note that some neonicotinoids are toxic to bees. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57. **Actara:** Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply during bloom and remove bee hives from the orchard before application. **Diazinon:** Highly toxic to bees and some beneficial insects.

Diseases and Insects	Products	Rate	Comments
Oystershell scale San Jose scale	• Movento 240 SC	365 mL/ha	Apply when the crawlers are active in orchards with a history of scale. **Movento:** Has slow activity; control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant / additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur.
Plum curculio	• Assail 70 WP • Actara 25 WG • Calypso 480 SC • Clutch 50 WDG • Imidan 50 WP • Zolone Flo • Surround WP	120 – 240 g/ha 385 g/ha 440 mL/ha 210g/ha 3.75 kg/ha 3 L/ha 50 kg/ha	**Assail, Actara, Calypso, Clutch (neonicotiniods):** Optimal timing is at petal fall plus 3 days. However if monitoring indicates plum curculio is in the orchard prior to this timing, then insecticides should be applied at petal fall. Do not use as a border spray. Note that some neonicotinoids are toxic to bees. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples*, page 57. **Actara:** Highly toxic to bees exposed to direct treatment or to residues on blooming crops and weeds. Do not apply during bloom, and remove bee hives from the orchard before application. **Imidan, Zolone:** Apply immediately at petal fall, or when monitoring indicates plum curculio is in the orchard. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012. **Surround:** Must be applied before plum curculio is present in orchard. Make two applications, 7 days apart, at 50 kg/ha, to establish a base layer. Continue at 7–14 day intervals, using a reduced rate of 25 kg/ha, to maintain even coverage of developing fruits. Do not use Surround in border sprays. See notes on *Kaolin Clay (Surround WP)*, page 247.
European apple sawfly	• Assail 70 WP • Calypso 480 SC	240 g/ha 290 mL/ha	Apply where there has been a history of damage. Use 3-D white sticky traps to monitor for sawfly adults. If a prebloom insecticide has been applied, spray postbloom when six sawflies have been caught per trap. Where no prebloom insecticides have been applied, spray postbloom when three sawflies have been caught per trap.

Diseases and Insects	Products	Rate	Comments
European red mite	• Agri-Mek 1.9% EC • Acramite 50 WS • Envidor 240 SC • Kanemite 15 SC • Apollo SC	750 mL/ha 851 g/ha or 3.75 pouches/ha 750 mL/ha 2.1 L/ha 300 mL/ha	Thorough spray coverage is essential for good control with miticides. See Table 4-9. *Activity of Miticides Registered on Apple and/or Pear in Ontario,* page 60. **Agri-Mek:** Apply when there are 5–7 active mites/leaf timed for 50% egg hatch, no later than 21 days after petal fall. Apply with 10 L Superior 70 Oil and a minimum of 1,000 L of water per ha. Agri-Mek plus oil may cause russeting on Golden Delicious and other light-skinned varieties. Do not use Agri-Mek plus oil within 14 days of a Captan or Maestro application. Alternate yearly with other early season miticides (e.g., Superior 70 Oil, Apollo). **Acramite, Envidor, Kanemite:** Apply when there are five or more active mites per leaf. **Agri-Mek, Envidor:** Also control apple rust mites. **Envidor:** Activity is slow; control may not be apparent for up to one week. **Apollo:** Kills mite eggs. Apply when mites are mostly in the egg stage and before there are more than three active mites per leaf. Apply Apollo alone in a minimum of 1,100 L of water per ha. **Purespray Green Spray Oil 13E:** Provides suppression of European Red Mite. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control. Summer oils can cause crop injury, depending on rate, cultivar, weather conditions, and recent pesticide applications. Do not use within 14 days of Captan or Maestro application. Read the label carefully for other precautions. See notes on *Mineral oil (Purespray Green Spray Oil 13E),* page 252. Do not apply any miticide more than once per season. To prevent development of pesticide resistance, rotate products from different groups. See *Managing resistance to insecticides and miticides,* page 255. Miticides are best applied alone.
Blister spot	• Aliette WDG	2 kg/ha	Apply preventatively to susceptible varieties such as Mutsu / Crispin and Golden Delicious. Begin applications at petal fall with 1–2 subsequent sprays at 7 day intervals. Do not mix with copper compounds.
Obliquebanded leafroller (OBLR)	• Success 480 SC or Entrust 80 W • Delegate WG • Intrepid 240 F • Confirm 240 F • Altacor • Dipel 2X DF or Foray 48BA or Bioprotec CAF	182 mL/ha 109 g/ha 420 g/ha 750 mL/ha 1 L/ha 215 g/ha 1.12 kg/ha 2.8 L/ha 4 L/ha	For overwintering OBLR, apply at petal fall. Spray in orchards with historical pest problems or high pest pressure (1–2% of the terminals or buds have larvae or damage). OBLR are resistant to organophosphate insecticides in most commercial apple orchards. Cross-resistance to pyrethroids, Confirm and Intrepid is possible. Avoid treating sequential generations with products from the same chemical group. See *Managing resistance to insecticides and miticides,* page 255. **Dipel, Foray, Bioprotec (B.t. products):** Make two applications at 5–7 day intervals if activity of the larvae is extended. For best results when using B.t. products, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days. See *Biopesticides for Insect Control,* page 247. Place pheromone traps in orchards at petal fall to monitor emergence summer generation of OBLR adults.

Diseases and Insects	Products	Rate	Comments
Oriental fruit moth (OFM)	• Assail 70 WP • Calypso 480 SC • Intrepid 240 F • Rimon 10 EC • Altacor • Delegate WG • Decis 5 EC	240 g/ha 440 mL/ha 1 L/ha 1.4 L/1,000 L water 215 g/ha 420 g/ha 250 mL/ha	This is a special spray for orchards where there is a history of damage or pressure. Timing is critical for effective control; use monitoring results to adjust spray timing. Apply insecticides 6-10 days after upswing in pheromone trap catches, which often coincides with petal fall. Alternatively, use this degree-day model to time the application of insecticides for OFM. Begin accumulating degree-days (base 7.2°C) at first sustained moth catch (biofix). Apply insecticides targeting first generation larvae: **Assail, Calypso:** Apply at 139–153 DDC for eggs or larvae. **Intrepid:** Apply at 139–153 DDC for eggs or larvae. **Rimon:** Apply at 111–139 DDC. Use for first generation only. See notes for codling moth, below. **Altacor, Delegate:** Apply at 194–208 DDC or earlier if using as an ovi-larvicide. **Decis:** Apply Decis at 194–208 DDC or earlier. See *Degree-day modeling and determining a biofix*, page 9. **Assail, Calypso (neonicotinoids):** Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples*, page 57. **Decis:** Highly toxic to beneficial insects and may lead to outbreaks of European red mite. Use only as a last resort. Use a maximum of 1 application per season. If an insecticide is used at this time to manage OFM the application of mating disruption products may be delayed until mid-June.
Codling moth	• Rimon 10 EC	1.4 L/1,000 L water	**Rimon:** Has a unique mode of action and should be applied earlier than other products for codling moth. Apply Rimon at petal fall and re-apply 10–14 days later. Use for first generation only. See label for additional information on rates and volumes. Do not allow Rimon to drift onto grapes as leaf spotting may occur. The application of Rimon at this time will provide subsequent control of obliquebanded leafroller and oriental fruit moth.
Apple leafcurling midge	• Ripcord 400 EC or Up-Cyde 2.5 EC	250 mL/ha 400 mL/ha	This is a special spray for orchards where there is a history of damage or pressure. **Ripcord, Up-Cyde (pyrethroids):** Do not apply more than once per season. Highly toxic to beneficial insects and may lead to outbreaks of European red mite.
Powdery mildew	Use one of the fungicides recommended at **Tight cluster to pink.**		
First summer spray (7–14 days after Petal fall (Calyx))			
Scab	Use one of the fungicides recommended at **Bloom.** An extra scab spray may be required between **Petal fall (Calyx)** and **First summer spray.** See *Control of apple scab under adverse weather conditions*, page 66.		
Plum curculio	Use one of the insecticides recommended under **Petal fall (Calyx).**		
Fire blight	• Streptomycin 17	600 g/1,000 L water	Apply to control shoot blight especially if blossom blight has occurred.

Diseases and Insects	Products	Rate	Comments
European red mite	• Agri-Mek 1.9% EC • Acramite 50 WS • Envidor 240 SC • Kanemite 15 SC • Apollo SC	750 mL/ha 851 g/ha or 3.75 pouches/ha 0.75 L/ha 2.1 L/ha 300 mL/ha	Thorough coverage is essential for good control with miticides. Miticides have different efficacy depending on life stage of each type of mite. See Table 4-9. *Activity of Miticides Registered on Apple and/or Pear in Ontario*, page 60. **Agri-Mek:** Apply when there are 5–7 active mites/leaf timed for 50% egg hatch, no later than 21 days after petal fall. Apply with 10 L of Superior 70 Oil and a minimum of 1,000 L of water per ha. Agri-Mek plus oil may cause russeting on Golden Delicious and other light-skinned cultivars. Do not apply within 14 days of Captan or Maestro application. Alternate yearly with other early season miticides (e.g. Superior 70 Oil, Apollo). **Acramite, Envidor, Kanemite:** Apply when there are five or more active mites per leaf. **Agri-Mek, Envidor:** Also control apple rust mites. **Envidor:** Activity is slow; control may not be apparent for up to one week. **Apollo:** Kills mite eggs. Apply when mites are mostly in the egg stage and before there are more than three active mites per leaf. Thorough coverage is essential for good control. Apply Apollo alone in a minimum of 1,100 L of water per ha. **Purespray Green Spray Oil 13E:** Provides suppression of European Red Mite. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. Summer oils can cause crop injury, depending on rate, cultivar, weather conditions, and recent pesticide applications. Do not use within 14 days of Captan or Maestro application. Read the label carefully for other precautions. See notes on *Mineral oil (Purespray Green Spray Oil 13E)*, page 252. Do not apply any miticide more than once per season. To prevent development of pesticide resistance, rotate products from different groups. See *Managing resistance to insecticides and miticides*, page 255.
Two-spotted spider mite	• Agri-Mek 1.9% EC • Acramite 50 WS • Envidor 240 SC • Kanemite 15 SC • Apollo SC	750 mL/ha 567 g/ha or 2.5 pouches/ha 0.75 L/ha 2.1 L/ha 300 mL/ha	
Rosy apple aphid	• Admire 240 F or Alias 240 SC • Assail 70 WP • Actara 25 WG • Calypso 480 SC • Clutch 50 WDG • Movento 240 SC • Zolone Flo • Beleaf 50 SG	230 mL/ha 230 mL/ha 120 g/ha 160 g/ha 145–290 mL/ha 140–210 g/ha 365 mL/ha 2 L/ha 160 g/ha	Controls should be applied if 20 or more infested clusters are present in a sample of 100 clusters. See comments at **Petal fall.** **Clutch:** Clutch is also labelled at 210–420 g/ha at this timing for suppression of oriental fruit moth and codling moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. **Movento:** Has slow activity; control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant / additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012.
Powdery mildew	Use one of the fungicides recommended under **Tight cluster to pink**.		
Blister spot	• Copper 53 W • Aliette WDG	3 kg/ha 2 kg/ha	Apply preventatively to Mutsu/Crispin, Golden Delicious and other susceptible varieties. **Copper 53 W:** To reduce the incidence of blister spot lesions, apply up to three sprays beginning 10 days after petal fall. To reduce the risk of phytotoxicity, use 6 kg of hydrated lime per 1 kg of Copper 53 W per 1,000 L of water. Apply in 3,000 L of water per ha. **Aliette:** Begin applications at petal fall and spray at 7 day intervals. Do not mix with copper compounds. Use a maximum of three applications per season.
Oriental fruit moth (OFM)	• Isomate-M100 • Isomate-M Rosso	250 dispensers/ha 500 dispensers/ha	Refer to mating disruption comments listed under **Half-inch green to tight cluster.** **Isomate-M100:** Make a second application of 75–80 days after the first. **Isomate-M Rosso:** Will provide control for up to 120 days.

Diseases and Insects	Products	Rate	Comments
Codling moth (first generation)	• Assail 70 WP • Calypso 480 SC • Intrepid 240 F • Confirm 240 F • Altacor • Delegate WG • Imidan 50 WP • Zolone Flo	170 g/ha 440 mL/ha 1 L/ha 1 L/ha 215 g/ha 420 g/ha 3.75 kg/ha 2 L/ha	Timing is critical for effective control. Apply as a full cover spray. Use pheromone traps to time sprays. Apply insecticides between 83-138 DDC (base 10°C) after first sustained moth catch. See *Degree-day modeling and determining a biofix*, page 9. Some products also control apple maggot or other pests. See Table 4-10. *Activity of Insecticides and Miticides on Apple Pests*, page 60. **Assail, Calypso (neonicotinoids):** Apply 1–2 days earlier (at 111–138 DDC) than OP insecticides. Residues last 10–14 days. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples*, page 57. **Intrepid and Confirm:** Apply Intrepid or Confirm 2–3 days earlier than OP insecticides (83–111 DDC). Intrepid residues last 14 or more days. **Altacor and Delegate:** Apply at 138 DDC. Residues last 10–14 days. **Imidan, Zolone (OP insecticides):** Apply for first generation codling moth at 138 DDC. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012. **Granulosis virus (Virosoft CP4 , CYD-X)**: May provide control of codling moth when used in conjunction with other active ingredients. For more information, see notes on *Cydia pomonella granulosis virus (Virosoft, CYD-X)*, page 248.
Subsequent summer sprays			
Scab	Until the end of the primary scab season use one of the fungicides recommended at **Bloom**. For summer (secondary) scab control, use one of the following:		
	• Manzate Pro-stick or Dithane DG or Penncozeb 75 DF • Polyram DF • Supra Captan 80 WDG or Maestro 80 DF • Allegro 500 F	6 kg/ha (5) 6 kg/ha (5) 2 kg/1,000 L water (1.5) 6 kg/ha (4.5) 3.75 kg/ha (1.9) 3.75 kg/ha (1.9) 0.75–1 L/ha	If scab is controlled in your orchard, use the lower rate given in brackets. **Polyram, Manzate, Dithane, Penncozeb:** Do not apply within 45 days of harvest. **Allegro:** May suppress European red mite, two spotted spider mite and apple rust mite.
Sooty blotch Fly speck	• Supra Captan 80 WDG or Maestro 80 DF • Flint 50 WG • Pristine WG • Inspire • Allegro 500 F	3.75 kg/ha 3.75 kg/ha 140 g/ha 600–800 g/ha 292 mL/ha 0.75–1 L/ha	**Captan, Maestro:** Repeat application in 2 weeks. At full rates these products protect against black rot. **Pristine:** Use the higher rate and a shorter interval during periods of rapid growth or when disease pressure is high. **Allegro:** May suppress European red mite, two spotted spider mite and apple rust mite. If fly speck and sooty blotch are a problem in the past, maintain fungicide coverage for these diseases starting at petal fall.

Diseases and Insects	Products	Rate	Comments
Codling moth (second generation)	• Assail 70 WP • Calypso 480 SC • Intrepid 240 F • Confirm 240 F • Altacor • Delegate WG • Imidan 50 WP • Zolone Flo	170 g/ha 440 mL/ha 1 L/ha 1 L/ha 215 g/ha 420 g/ha 3.75 kg/ha 2 L/ha	Timing is critical for effective control. Use pheromone traps to time sprays. For second generation codling moth, spray at 611–694 DDC (base 10° C) after **first generation sustained moth catch.** See *Degree-day modeling and determining a biofix,* page 9. Some products also control apple maggot or other pests. See Table 4-10. *Activity of Insecticides and Miticides on Apple Pests,* page 60. **Assail, Calypso (neonicotinoids):** Apply 1–2 days earlier than OP insecticides (639–667 DDC). Residues last 10–14 days. Do not apply as a border spray. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57. **Intrepid and Confirm:** Apply 2–3 days earlier than OP insecticides (611–639 DDC). Intrepid residues last 14+ days. Do not apply as a border spray. **Altacor, Delegate:** Apply 1–2 days earlier than OP insecticides (667–694 DDC). Do not apply as a border spray. **Imidan, Zolone (OP insecticides):** Apply at 667–694 DDC. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012. **Granulosis virus (Virosoft CP4 , CYD-X):** May provide control of codling moth when used in conjunction with other active ingredients. For more information, see notes on *Cydia pomonella granulosis virus* , page 248.
Oriental fruit moth	• Isomate-M100 • Isomate-M Rosso	250 dispensers/ha 500 dispensers/ha	Refer to mating disruption comments listed under **Half-inch green to tight cluster.** **Isomate-M100:** Make a second application 75–80 days following first application. **Isomate-M Rosso:** Provides control for up to 120 days.
Apple maggot	• Assail 70 WP • Calypso 480 SC • Imidan 50 WP • Zolone Flo • Diazinon 50 WSP • Surround WP	120–240 g/ha 440 mL/ha 3.75 kg/ha 3 L/ha 1 kg/1,000 L water 50 kg/ha	Use trap catches to time the first spray. Make subsequent applications at 14–21 day intervals or as required based on monitoring. **Assail, Calypso (neonicotinoids):** Apply 7 days after the first adult maggot is caught on a sticky board. Residue lasts 14 days. Use a maximum of two neonicotinoid applications per season. Repeated use of neonicotinoids may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57. Not recommended as a border spray. **Imidan, Zolone, Diazinon (OP insecticides):** Apply 7 days after the first adult maggot is caught on a sticky board. Residues last approximately 18–21 days. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012. **Surround:** Begin applications well before first maggot flies are trapped in commercial orchards, and continue at 7–14 day intervals to maintain even coverage of fruit as long as flies continue to be captured. Use 50 kg/ha for the first two applications of the season, continue at 25 kg/ha. Do not use Surround in border sprays. See notes on *Kaolin Clay (Surround WP),* page 247. **GF-120 NF (spinosad bait):** Provides suppression of apple maggot. See notes on *GF-120 NF Naturalyte Fruit Fly Bait,* page 251.

Diseases and Insects	Products	Rate	Comments
Special summer sprays			
Blister spot	• Copper 53 W • Aliette WDG	3 kg/ha 2 kg/ha	See comments on blister spot control under **First summer spray.**
Green apple aphid (GAA) Rosy apple aphid (RAA)	• Admire 240 F or Alias 240 SC • Assail 70 WP • Calypso 480 SC • Clutch 50 WDG • Movento 240 SC • Zolone Flo • Diazinon 50 WSP • Beleaf 50 SG	230 mL/ha 230 mL/ha 120 g/ha 145–290 mL/ha 140–210 g/ha 365 mL/ha 2 L/ha 0.5–1 kg/1,000 L water 160 g/ha	Spray for GAA if 10% of terminals are infested. Sprays can be delayed or avoided if predators are present on more than 20% of infested terminals. Apply RAA sprays if 20 or more infested clusters are present per 100 clusters examined. **Admire, Alias, Assail, Calypso, Clutch (neonicotinoids):** Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57. **Clutch:** Clutch is also labelled at 210–420 g/ha at this timing for suppression of oriental fruit moth and codling moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control. **Movento:** Has slow activity; control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant / additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012.
Woolly apple aphid	• Diazinon 500 E • Malathion 25 W or Malathion 85 E • Zolone Flo • Movento 240 SC	0.5–1 L/1,000 L water 2–5 kg/1,000 L water 610 mL/1,000 L water 2 L/ha 365 mL/ha	Spray if aphid colonies are close to fruit clusters or on young trees and nursery stock. Use high volumes of water and ensure spray contacts trunk and scaffold limbs. Repeat application in 14 days if woolly apple aphid is still present. **Malathion 85 E:** May cause injury to McIntosh and Cortland if applied within 4 weeks of harvest. **Movento:** Has slow activity; control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant / additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012.
White apple leafhopper	• Admire 240 F or Alias 240 SC • Calypso 480 SC • Clutch 50 WDG • Sevin XLR	200 mL/ha 200 mL/ha 145 mL/ha 140–210 g/ha 3.1 L/ha	Spray when nymphs are present (2–5 per leaf). There are two generations of nymphs per season, in mid-June and early August. Control of adults is very difficult. **Admire, Alias, Assail, Calypso, Clutch (neonicotinoids):** Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57. **Clutch:** Clutch is also labelled at 210–420 g/ha at this timing for suppression of oriental fruit moth and codling moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control. **Assail:** Applied at a rate of 120 g/ha for aphids will control leafhoppers.
Potato leafhopper	• Calypso 480 SC • Clutch 50 WDG	145 mL/ha 140–210 g/ha	Apply where monitoring indicates a potential problem. **Calypso, Clutch (neonicotinoids):** Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57. **Clutch:** Clutch is also labelled at 210–420 g/ha at this timing for suppression of oriental fruit moth and codling moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control. **Assail:** Applied at a rate of 120 g/ha for aphids will also control leafhoppers.

Diseases and Insects	Products	Rate	Comments
Tentiform leafminer	• Admire 240 F or Alias 240 SC • Assail 70 WP • Calypso 480 SC • Clutch 50 WDG • Altacor • Delegate WG • Pounce 384 EC or Perm-Up or Ambush 500 EC • Decis 5 EC • Ripcord 400 EC or Up-Cyde 2.5 EC • Matador 120 EC or Silencer 120 EC	380 mL/ha 380 mL/ha 80 g/ha 290 mL/ha 140–210 g/ha 215 g/ha 420 g/ha 520 mL/ha 520 mL/ha 400 mL/ha 250 mL/ha 250 mL/ha 400 mL/ha 83 mL/ha 83 mL/ha	From petal fall though July: Apply controls where there are one or more sap-feeding mines per leaf. From mid to late June through July: Apply where there are two mines per leaf (stressed trees) or four mines per leaf (healthy trees). **Admire, Alias, Assail, Calypso, Clutch (neonicotinoids):** Apply when populations are mainly in the sap-feeder stage. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. See Table 4-7. *Products Used on Apples,* page 57. **Calypso:** Note rate change from first to second generation. **Clutch:** Clutch is also labelled at 210–420 g/ha at this timing for suppression of oriental fruit moth and codling moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control. **Pounce, Ambush, Perm-Up, Ripcord, Up-Cyde, Decis, Matador, Silencer (pyrethroids):** Use is discouraged for summer generations of tentiform leafminer. Pyrethroids are highly toxic to beneficial insects and may lead to outbreaks of European red mite. These products do not control larvae within the mines.
Dogwood borer Apple bark borer	• Pounce 384 EC plus Superior Oil or Perm-Up plus Superior Oil	22 mL/100 L water with 2 L oil 22 mL/100 L water with 2 L oil	Apply insecticides to tree trunk seven days after peak flight of adults in orchards with a history of borer problems. Make two applications at 2–3 week intervals. Soak the trunk.
Apple clear wing moth	• Entrust 80 W	75 g/ha	This is not a common pest in Ontario. Make the first application within 10 days of first adult emergence and repeat application at 7 to 10 day intervals throughout the period of adult activity, up to a maximum of 7 applications.
Obliquebanded leafroller (OBLR)	• Success 480 SC or Entrust 80 W • Delegate WG • Altacor • Dipel 2X DF or Foray 48BA or Bioprotec CAF	182 mL/ha 109 g/ha 420 g/ha 215 g/ha 1.12 kg/ha 2.8 L/ha 4 L/ha	Place pheromone traps in orchards by June to monitor adult populations. Insecticides for summer generation larvae should be applied at 240–280 DDC after first sustained moth catch (base 6.1°C). See *Degree-day modeling and determining a biofix,* page 9. When applied for leafroller control, these products also control other leaf-feeding caterpillars. OBLR are resistant to organophosphate insecticides in most commercial apple orchards. Cross-resistance to pyrethroids, Confirm, and Intrepid is possible. Avoid treating sequential generations with the products from the same chemical group. See Table 12-3. *Insecticide and Miticide Groups Based on Sites of Action,* page 258. **Success, Entrust:** Monitor populations and re-apply as necessary on a 7–10 day schedule. Use a maximum of three applications per season. **Dipel, Foray, or Bioprotec:** Make two applications at 5–7 day intervals if activity of the larvae is extended. For best results acidify spray mix to below pH 7.0 and apply at dusk or on overcast days. See *Biopesticides for Insect Control,* page 247. **Intrepid, Confirm:** Provide suppression of OBLR at this timing. Apply a second spray 10–14 days after the first application. See label for specific timing. Use a maximum of two applications per season.

Diseases and Insects	Products	Rate	Comments
Oriental fruit moth (OFM)	• Assail 70 WP	240 g/ha	This is a special spray for orchards where there is a history of damage or pressure. Timing is critical for effective control; use monitoring results to adjust spray timing. Apply sprays 3–6 days after the upswing in moth flight for subsequent generations. If using the degree-day model for OFM sprays, begin accumulating degree-days (base 7.2°C) after first sustained moth catch of the first generation. See *Degree-day modeling and determining a biofix,* page 9. Apply insecticides for 2nd generation OFM as follows: **Assail, Calypso, Intrepid:** 750–778 DDC **Altacor, Delegate, Decis:** 805–833 DDC For 3rd generation OFM (1st spray): **Assail, Calypso, Intrepid:** 1305–1333 DDC **Altacor, Delegate, Decis:** 1361–1389 DDC For 3rd generation (2nd spray): **Assail, Calypso, Intrepid:** 1556–1611 DDC **Altacor, Delegate, Decis:** 1611–1667 DDC **Decis:** Highly toxic to beneficial insects and may lead to outbreaks of European red mite. Use only as a last resort. Rotate between products in different chemical families to deter the development of pesticide resistance. See Table 12-3. *Insecticide and Miticide Groups Based on Sites of Action,* page 258.
	• Calypso 480 SC	440 mL/ha	
	• Intrepid 240 F	1 L/ha	
	• Altacor	215 g/ha	
	• Delegate WG	420 g/ha	
	• Decis 5 EC	250 mL/ha	
European red mite	• Nexter	300 g/ha	Thorough coverage is essential for good control with miticides. Use a minimum of 1,000 L/ha of water when applying summer miticides. Miticides have different efficacy depending on life stage of each type of mite. See Table 4-9. *Activity of Miticides Registered on Apple and/or Pear in Ontario,* page 60. **Nexter:** Apply when there are 7–10 active mites/leaf in June to mid-July or 10–15 active mites/leaf in July and August. **Acramite, Envidor, Kanemite:** Apply when there are five or more active mites per leaf. **Envidor, Nexter, Kelthane:** Also control apple rust mite. **Envidor:** Activity is slow; control may not be apparent for up to one week. Do not apply any miticide more than once per season. To prevent development of pesticide resistance, rotate products from different groups. See *Managing resistance to insecticides and miticides,* page 255. Miticides are best used alone. **Purespray Green Spray Oil 13E:** Provides suppression of European Red Mite. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control. Summer oils can cause crop injury, depending on rate, cultivar, weather conditions, and recent pesticide applications. Do not use within 14 days of Captan or Maestro application. Read the label carefully for other precautions. See notes on *Mineral oil (Purespray Green Spray Oil 13E),* page 252.
	• Acramite 50 WS	851 g/ha or 3.75 pouches/ha	
	• Envidor 240 SC	0.75 L/ha	
	• Kanemite 15 SC	2.1 L/ha	
Two-spotted spider mite	• Nexter	600 g/ha	
	• Acramite 50 WS	567 g/ha or 2.5 pouches/ha	
	• Envidor 240 SC	0.75 L/ha	
	• Kanemite 15 SC	2.1 L/ha	
Japanese beetle	• Imidan 50 WP	3.75 kg/ha	Japanese beetles are a recent problem in some Ontario orchards, especially in young plantings of Honeycrisp. If Japanese beetles cause economic damage, insecticides may be necessary.
	• Calypso 480 SC	145–290 mL/ha	
Pinpoint and storage scab	Use one of the fungicides recommended for secondary scab in **Subsequent summer sprays.** Do not use fungicides closer than the stated interval to harvest. See Table 4-7. *Products Used on Apples,* page 57.		
Preharvest sprays			
Botrytis grey mould Penicillium storage diseases (suppression)	• Scala SC	2 L/ha	**Scala:** Apply 2 weeks before harvest. **Captan, Maestro:** Summer applications provide some protection against storage rots.

Diseases and Insects	Products	Rate	Comments
Postharvest treatment			
Blue mould Grey mould	• Mertect SC • Scholar 230 SC	500 mL/500 L water 496 mL/378 L water	**Mertect:** Continuous agitation is required. Follow label instructions. Does not control blue mould *(Penicillium)* or grey mould *(Botrytis),* that are resistant to benzimidazole fungicides. **Scholar:** For use in dip tank or drencher. Treats up to 90,000 kg of fruit. For dip treatments, dip fruit for approximately 30 seconds, then allow fruit to drain. **Bio-save 10 LP:** Provides suppression of storage rots. See *Pseudomonas syringae* (Bio-Save 10 LP), page 243.

Guidelines for Protecting Non-Bearing Apple Plantings

The following program is designed to offer limited protection when needed for newly planted trees. It is not intended for protection of bearing orchards. To minimize pest pressure, remove neglected fruit trees in the area and control weeds. Alternate materials are available as shown in the calendar for bearing fruits.

Diseases and Insects	Products	Comments
Early spring		
Phytophthora collar rot	• Ridomil Gold 480 SL	Do not apply if Ridomil was applied the previous fall.
First sprays		
Scab	• Manzate Pro-stick or Dithane DG or Penncozeb 75 DF • Polyram DF • Supra Captan 80 WDG or Maestro 80 DF	Apply fungicides before spore release and keep growing leaves covered. See *Apple scab,* page 64 for information on infection periods. Alternate materials from different groups. **Serenade MAX:** Provides suppression of apple scab. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)* page 242. See *Managing resistance to fungicides,* page 254.
Powdery mildew	• Nova 40 W • Nustar • Sovran • Flint 50 WG • Pristine WG • Microthiol Disperss	Spray susceptible varieties. Begin application at **Tight cluster** and continue to **First summer spray.** Additional sprays beyond **First summer spray** may be needed on susceptible varieties or if disease pressure is severe. Biopesticides are available for powdery mildew suppression. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control, and notes on Serenade MAX, *Bacillus subtilis (Serenade ASO, Serenade MAX)* page 242.
Prebloom		
Tentiform leafminer	• Assail 70 WP • Actara 25 WG • Calypso 480 SC • Confirm 240 F • Intrepid 240 F • Altacor • Delegate WG • Pounce 384 EC or Perm-Up or Ambush 500 EC • Decis 5 EC • Ripcord 400 EC or Up-Cyde 2.5 EC • Matador 120 EC or Silencer 120 EC	Monitor for tentiform leafminer and apply sprays when thresholds are reached. See comments on thresholds for tentiform at **Tight cluster to pink stage,** page 42. **Assail, Actara, Calypso (neonicotinoids):** Some neonicotinoids are toxic to bees. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. **Pounce, Ambush, Perm-Up, Ripcord, Up-Cyde, Decis, Matador, Silencer (pyrethroids):** Do not apply more than once per season. Highly toxic to beneficial insects and may lead to outbreaks of European red mite.

Diseases and Insects	Products	Comments
Leaf-feeding caterpillars	• Imidan 50 WP • Zolone Flo	Apply when caterpillars are small. Include with a fungicide spray. Not necessary if a pyrethroid was used for tentiform leafminer. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012.
Bloom		
Fire blight	• Streptomycin 17	Avoid over stimulating growth. Biopesticides are available for fire blight suppression. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control, and notes on Serenade MAX, *Bacillus subtilis (Serenade ASO, Serenade MAX),* page 242 and Bloomtime, *Pantoea agglomerans (Bloomtime Biological FD),* page 243.
Postbloom		
Leaf curling midge	• Ripcord 400 EC or Up-Cyde 2.5 EC	**Ripcord, Up-Cyde (pyrethroids):** Do not apply more than once per season. Highly toxic to beneficial insects and may lead to outbreaks of European red mite.
Summer sprays		
Leaf-feeding insects	• Imidan 50 WP • Zolone Flo	This spray will also control potato leafhopper. **Zolone:** Registration will be withdrawn in 2013. Do not use after September 30, 2012.
Aphids	• Admire 240 F or Alias 240 SC • Assail 70 WP • Actara 25 WG • Clutch 50 WDG • Movento 240 SC • Diazinon 50 WSP	Spray if insects become abundant at any time. **Admire, Alias, Assail, Actara, Clutch (neonicotinoids):** Some neonicotinoids are toxic to bees. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks.
White apple leafhopper	• Admire 240 F or Alias 240 SC • Assail 70 WP • Calypso 480 SC • Clutch 50 WDG	**Admire, Alias, Assail, Calypso, Clutch (neonicotinoids):** Some neonicotinoids are toxic to bees. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks.
Potato leafhopper	• Assail 70 WP • Calypso 480 EC • Clutch 50 WDG	**Assail, Calypso, Clutch (neonicotinoids):** Some neonicotinoids are toxic to bees. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks.
Tentiform leafminer	• Admire 240 F or Alias 240 SC • Assail 70 WP • Actara 25 WG • Calypso 480 EC • Clutch 50 WDG • Altacor • Delegate WG • Vydate L	Monitor for tentiform leafminer and apply sprays when thresholds are reached. See comments on thresholds for tentiform leafminer under **Special Summer Sprays.** **Admire, Alias, Actara, Assail, Calypso, Clutch (neonicotinoids):** Some neonicotinoids are toxic to bees. Use a maximum of two applications of neonicotinoid insecticides per season. Repeated use of this group may result in mite outbreaks. **Vydate:** Very toxic to applicator. Timing is critical. If mines are visible on underleaf surface, contact a crop consultant.
Mites	• Nexter • Acramite 50 WS • Envidor 240 SC • Kanemite 15 SC	Monitor for mites. Spray if more than 10 mites per leaf are observed or at first sign of leaf bronzing.
Buffalo treehopper		Follow clean cultivation practices or remove legumes from cover crop.
Phytophthora collar rot	• Ridomil Gold 480 SL	
Root lesion nematode		See *Nematodes,* page 223, and *Nematode suppression after planting,* page 225.

Table 4-7. Products Used on Apples

Use this table as a guide, but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between when you apply the pesticide and when you work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume that it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry period	Maximum number of applications per season (on label)
Products used to control or suppress insects and mites						
Acramite 50 WS	27925	bifenazate	25	7 days	12 hours	1
Actara 25 WG	28408	thiamethoxam	4	60 days	12 hours	2 (max. 770 g/ha)
Admire 240 F	24094	imidacloprid	4	7 days	24 hours	2
Agri-Mek 1.9% EC	24551	abamectin	6	28 days		1
Alias 240 SC	28475	imidacloprid	4	7 days	24 hours	2
Altacor	28981	chlorantraniliprole	28	5 days	12 hours	3
Ambush 500 EC	14882	permethrin	3	7 days		
Apollo SC	21035	clofentezine	10	petal fall[1]	12 hours	1
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours/48 hours/ 6 days[2]	4
Beleaf 50 SG	29796	flonicamid	9C	21 days	12 hours/48 hours[3]	3 (max. 0.48 kg/ha)
Bioprotec CAF	26854	*Bacillus thuringiensis*	11	1 day		
Calypso 480 SC	28429	thiacloprid	4	30 days	12 hours	3 (max. 875 mL/ha)
Carzol SP Instapak	29991	formetanate hydrochloride	1A	14 days	12 days/14 days/ 19 days[2]	1
Clutch 50 WDG	29382	clothianidin	4	7 days	12 hours	2
Confirm 240 F	24503	tebufenozide	18	14 days	12 hours	4
Cyd-X	30120	granulosis virus	NC	0 days		
Decis 5 EC	22478	deltamethrin	3	1 day		3
Delegate WG	28778	spinetoram	5	7 days	12 hours	3
Diazinon 50 WSP	29976	diazinon	1B	14 days	4 days	
Diazinon 500 E	11889	diazinon	1B	14 days	4 days	
Dipel 2X DF	26508	*Bacillus thuringiensis*	11	1 day		
Entrust 80 W	27825	spinosad	5	7 days		3/7[4]
Envidor 240 SC	28051	spirodiclofen	23	7 days	12 hours	1
Foray 48BA	24978	*Bacillus thuringiensis*	11	1 day		
GF-120 NF	28336	spinosad bait	5			10
Imidan 50 WP	23006	phosmet	1B	14 days	7 days/14 days[5]	5
Intrepid 240 F	27786	methoxyfenozide	18	14 days	12 hours	2 (max. 2 L/ha)
Kanemite 15 SC	28641	acequinocyl	20	14 days	12 hours	2 (max. 4.1 L/ha)
Malathion 25 W	14656	malathion	1B	3 days		
Malathion 85 E	8372	malathion	1B	3 days		
Matador 120 EC	24984	lambda-cyhalothrin	3	7 days	24 hours	3
Movento 240 SC	28593	spirotetramat	23	7 days	12 hours	max. 1.83 L/ha
Nexter	25135	pyridaben	21	25 days	24 hours	2
Perm-Up	28877	permethrin	3	7 days	12 hours	

A blank cell indicates the information is not specified on the product label.

[1] Apply no later than 14 days after petal fall.

[2] Re-entry period as follows: re-entry/contact and scouting activities/hand thinning.

[2a] Re-entry period as follows: re-entry/hand harvest/hand thinning.

[3] Re-entry period as follows: re-entry/hand thinning.

[4] 3 applications for obliquebanded leafroller, 7 applications for apple clearwing moth.

[5] Re-entry period as follows: re-entry/pick-your-own harvest.

[6] 2 applications per codling moth generation.

[7] 14 days *(Botrytis)*, 72 days (scab).

Table 4-7. Products Used on Apples (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry period	Maximum number of applications per season (on label)
Pounce 384 EC	16688	permethrin	3	7 days		
Rimon 10 EC	28881	novaluron	15	14 days	12 hours	4
Ripcord 400 EC	15738	cypermethrin	3	7 days		2
Sevin XLR	27876	carbaryl	1A	11 days		
Silencer 120 EC	29052	lambda-cyhalothrin	3	7 days	24 hours	3
Purespray Green Spray Oil 13 E	27666	mineral oil	NC		12 hours	1 (full rate)
Success 480 SC	26835	spinosad	5	7 days		3
Superior 70 Oil	9542 14981	mineral oil			12 hours	1 (full rate)
Surround WP	27469	kaolin		1 day		
Up-Cyde 2.5 EC	28795	cypermethrin	3	7 days	12 hours	3
Virosoft CP4	26533	granulosis virus	NC			4[6]
Vydate L	17995	oxamyl	1A	non-bearing only	24 hours	
Zolone Flo	17983	phosalone	1B	30 days	14 days/30 days[5]	3
Products used for disease control or suppression						
Aliette WDG	24458	fosetyl al	U	30 days		3
Allegro 500 F	27517	fluazinam	29	28 days	24 hours/3 days[3]	9
Apogee	28042	prohexadione calcium		45 days	12 hours	4 (max. 5.4 kg/ha)
Bio-Save 10 LP	29673	*Pseudomonas syringae*	NC			1
Bloomtime Biological FD	28436	*Pantoea agglomerans* strain E325	NC	0 days	4 hours	2
Copper 53 W	9934	tri-basic copper sulphate	M	30 days	48 hours	3
Dithane DG	29221	mancozeb	M	45 days		
Ferbam 76 WDG	20136	ferbam	M	7 days		
Flint 50 WG	27529	trifloxystrobin	11	14 days	12 hours/4 days[3]	4 (max. 770 g/ha)
Inspire	30004	difenoconazole	3	14 days	12 hours/4 days[3]	5 (max. 1.46 L/ha)
Kumulus DF	18836	sulphur	M	1 day	24 hours	
Maestro 80 DF	26408	captan	M	7 days	48 hours	
Manzate Pro-stick	28217	mancozeb	M	45 days		
Mertect SC	13975	thiabendazole	1	postharvest		
Microscropic Sulphur	14653	sulphur	M	1 day	24 hours	
Microthiol Disperss	29487	sulphur	M	1 day	24 hours	8
Nova 40 W	22399	mycobutanil	3	14 days		6
Nustar	25547	flusilazole	3	77 days	12 hours	4
Penncozeb 75 DF	25397	mancozeb	M	45 days	24 hours	
Polyram DF	20087	metiram	M	45 days		
Pristine WG	27985	boscalid + pyraclostrobin	7+11	5 days	when dry/ 5 days/12 days[2a]	4
Ridomil Gold 480 SL	28474	metalaxyl-M and S	4	non-bearing only	12 hours	2
Scala SC	28011	pyrimethanil	9	14 days/72 days[7]	12 hours/24 hours[3]	5

A blank cell indicates the information is not specified on the product label.

[1] Apply no later than 14 days after petal fall.

[2] Re-entry period as follows: re-entry/contact and scouting activities/hand thinning.

[2a] Re-entry period as follows: re-entry/hand harvest/hand thinning.

[3] Re-entry period as follows: re-entry/hand thinning.

[4] 3 applications for obliquebanded leafroller, 7 applications for apple clearwing moth.

[5] Re-entry period as follows: re-entry/pick-your-own harvest.

[6] 2 applications per codling moth generation.

[7] 14 days *(Botrytis)*, 72 days (scab).

Table 4-7. Products Used on Apples (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry period	Maximum number of applications per season (on label)
Scholar 230 SC	29528	fludioxonil	12			1
Serenade MAX	28549	*Bacillus subtilis*	44	0 days		
Sovran	26257	kresoxim-methyl	11	30 days	48 hours	4
Streptomycin 17	10305	streptomycin sulphate	18	50 days	24 hours/7 days/ 14 days[2]	3
Supra Captan 80 WDG	24613	captan	M	7 days	48 hours	
Vangard 75 WG	25509	cyprodinil	9	72 days	72 hours	2 (max. 1.5 kg/ha)

A blank cell indicates the information is not specified on the product label.

[1] Apply no later than 14 days after petal fall.

[2] Re-entry period as follows: re-entry/contact and scouting activities/hand thinning.

[2a] Re-entry period as follows: re-entry/hand harvest/hand thinning.

[3] Re-entry period as follows: re-entry/hand thinning.

[4] 3 applications for obliquebanded leafroller, 7 applications for apple clearwing moth.

[5] Re-entry period as follows: re-entry/pick-your-own harvest.

[6] 2 applications per codling moth generation.

[7] 14 days *(Botrytis)*, 72 days (scab).

Notes on Apple Insects

Use the information in the following notes to assist with choosing the best product for the pest complex present. Consider the life stage present and resistance management strategies, as well as the activity of each product to pests and beneficials. Table 4-10. *Activity of Insecticides and Miticides on Apple Pests*, page 60, provides information on the activity of insecticides and miticides to apple pests. Table 4-11. *Toxicity of Pesticides to Mite and Aphid Predators*, page 63, provides information on the effect of these products on beneficial insects and mites.

Table 4-8. Activity of Petal Fall Insecticides Against Orchard Pests

Ratings in shaded cells indicate the pest is listed on the product label for control or suppression. Use insecticides only for insect listed on the product label for the crop and for the insect. Where ratings are not in shaded cells, some activity against this insect is anticipated, but this use is not on the product label. Consult the label for more information. The information provided in this table is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Insecticide	Group	Obliquebanded leafroller	Oriental fruit moth	Codling moth (eggs)	Plum curculio	Mullein bug	Tentiform leafminer	Japanese beetle	European apple sawfly
Actara 25 WG	4				✓	✓	✓		
Assail 70 WP	4		✓		✓	✓	✓	✓	✓
Calypso 240 SC	4		✓		✓	✓	✓	✓	✓
Clutch 50 WDG	4		✓s	✓s	✓		✓		
Delegate WG	5	✓	✓		✓s		✓		
Success 480 SC	5	✓							
Bioprotec CAF	11	✓							
Dipel 2X DF	11	✓							
Foray 48BA	11	✓							
Rimon 10 EC	15	✓	✓	✓					
Intrepid 240 F	18	✓	✓				✓		
Altacor	28	✓	✓				✓		

✓ = Has activity on the pest.

s = Suppression.

Table 4-9. Activity of Miticides Registered on Apple and/or Pear in Ontario*

Product	**Target Species**	**Life stage(s) affected**	**Preferred timing**	**Comments on Knock-down**
Acramite 50 WS	European red mite (apple) Two-spotted spider mite (apple)	Nymphs, adults	Postbloom	Rapid
Agri-Mek 1.9% EC	European red mite Two-spotted spider mite Pear rust mite (pear)	Nymphs	Within 21 days of petal fall	Rapid
Apollo SC	European red mite Two-spotted spider mite	Primarily eggs, newly hatched nymphs	Egg stage, before >3 active mites per leaf, no later than 14 days after petal fall	Slow activity
Carzol SP	European red mite Two-spotted spider mite	Nymphs, adults	Summer	Rapid
Envidor 240 SC	European red mite Two-spotted spider mite Apple rust mite (apple) Pear rust mite (pear)	Eggs, nymphs, adult females	Postbloom only	Slow activity
Kanemite 15 SC	European red mite Two-spotted spider mite	All life stages	Postbloom	Rapid
Nexter	European red mite (ERM) Apple rust mite (ARM) Two-spotted spider mite (TSSM) Pear rust mite (PRM) (pear)	Nymphs and adults of ERM, ARM and PRM Nymphs of TSSM No effect on eggs	Summer	Rapid
Purespray Green Spray Oil 13 E	European red mite	Overwintering eggs, some nymphs	Half-inch green to tight cluster prior to hatch	Smothers eggs
Superior 70 Oil	European red mite	Overwintering eggs, some nymphs	Half-inch green to tight cluster prior to hatch	Smothers eggs

* Registered for use on apple or pear unless indicated otherwise. Use established thresholds to time applications. Miticides are most effective when applied alone, using recommended rates and water volumes. Apply each miticide only once per season to delay the development of resistance.

Table 4-10. Activity of Insecticides and Miticides on Apple Pests

Ratings in shaded cells indicate the pest is listed on the product label for control or suppression. Use products only for pests listed on the product label for the crop and for the pest. Additional information is provided in this table to assist the grower in choosing the best product for control of pests listed on the product label.

Insecticide	**Plum curculio**	**European apple sawfly**	**Oriental fruit moth**	**Spring feeding caterpillar**	**Obliquebanded leafroller**	**Tentiform leafminer**	**San Jose scale**	**Codling moth**	**Mullein bug**	**Tarnished plant bug**	**White apple leafhopper**	**Potato leafhopper**	**Rosy apple aphid**	**Green apple aphid**	**Woolly apple aphid**	**Apple maggot**	**Leaf curling midge**	**European red mite**	**Two-spotted spider mite**	**Apple rust mite**	**Apple clearwing moth**	**Japanese beetle**
Acramite 50 WS																		+++	++++			
Actara 25 WG	+++	++	+			+++			+++	+++	++++	++++	++++	++++								
Admire 240 F						++++			+++	+	++++	++++	++++	++++	++							
Alias 240 SC						++++			+++	+	++++	++++	++++	++++	++							

+ Reduction in damage.
++ Suppression.
+++ Good control with some limitations.
++++ Excellent control.
M = May cause mite flare ups.
R = Resistant.
ES = Early season applications only.
Blank cell = Information is unavailable.

Ratings are based on moderate insect or mite pressure. Heavy infestations may require either higher dosage or shorter intervals, or both. Efficacy may be affected by rate of insecticide used, as well as coverage, timing and residual of the product. In some orchards, resistance may cause control failures when present. See *Pest Resistance to Insecticides, Fungicides and Miticides*, page 253. Products must be applied at proper timings and label rates for each pest/. Consult label or apple calendar for this information.

Adapted from Cornell Pest Management Guidelines for Tree Fruit and the Pennsylvania Tree Fruit Production Guide.

Table 4-10. Activity of Insecticides and Miticides on Apple Pests (cont'd)

Insecticide	Plum curculio	European apple sawfly	Oriental fruit moth	Spring feeding caterpillar	Obliquebanded leafroller	Tentiform leafminer	San Jose scale	Codling moth	Mullein bug	Tarnished plant bug	White apple leafhopper	Potato leafhopper	Rosy apple aphid	Green apple aphid	Woolly apple aphid	Apple maggot	Leaf curling midge	European red mite	Two-spotted spider mite	Apple rust mite	Apple clearwing moth	Japanese beetle
Agri-Mek 1.9% EC +oil						++++ ES					++	++						+++ ES	+++ ES	+++ ES		
Altacor	+		++++	++++	++++	++++		++++								+						
Ambush 500 EC (M)	++	+++		+++	+R	+++				+++	++++		++			+++						
Apollo SC																		+++ ES	++ES	+ES		
Assail 70 WP (M)	+++	+++	++++	+++	+	++++	++	+++	+++	++	++++	++++	++++	++++	+	++++	++					++++
Beleaf 50 SG										++			+++	+++	++							
Bioprotec CAF				+++	+++			+														
Calypso 480 SC (M)	+++	++++	+++		+	++++	+	+++	+++	+++	++++	++++	++++	++++	+	+++						++++
Carzol SP Instapak											++++							+++	+++	+++		
Clutch 50 WDG	++++		++		+	++++		++			++++	++++	++++	++++								
Confirm 240 F				+++	+++R	+++		+++														
Decis 5 EC			+++	+++	++R	+++		+++	+	+++	++++	++++	+++	+	+	+++	++					
Delegate WG	++		++++	++++	++++	++++		++++								++						
Diazinon 50 WSP	++			++		+	+++	++	++++	+++	+	+	++++	+++	++++	++						
Dipel 2X DF				+++	+++			+														
Envidor 240 SC																		++++	++++	++++		
Foray 48 BA				+++	+++			+														
Imidan 50 WP	++++	+++	+++R	+++	++R	+	+	+++R		++	+	+	+	++	+	+++						+
Intrepid 240 F			+++ ES	++++	+++R	+++		+++														
Kanemite 15 SC																		++++	++++			
Matador 120 EC (M)	++	+++	+++	+++	+R	+++	+	+++		+++	++++	++++	+++	++	+	+++	++					
Movento 240 SC							+++						+++	+++	+++							

+ Reduction in damage.
++ Suppression.
+++ Good control with some limitations.
++++ Excellent control.
M = May cause mite flare ups.
R = Resistant.
ES = Early season applications only.
Blank cell = Information is unavailable.

Ratings are based on moderate insect or mite pressure. Heavy infestations may require either higher dosage or shorter intervals, or both. Efficacy may be affected by rate of insecticide used, as well as coverage, timing and residual of the product. In some orchards, resistance may cause control failures when present. See *Pest Resistance to Insecticides, Fungicides and Miticides*, page 253. Products must be applied at proper timings and label rates for each pest/. Consult label or apple calendar for this information.

Adapted from Cornell Pest Management Guidelines for Tree Fruit and the Pennsylvania Tree Fruit Production Guide.

Table 4-10. Activity of Insecticides and Miticides on Apple Pests (cont'd)

Insecticide	Plum curculio	European apple sawfly	Oriental fruit moth	Spring feeding caterpillar	Obliquebanded leafroller	Tentiform leafminer	San Jose scale	Codling moth	Mullein bug	Tarnished plant bug	White apple leafhopper	Potato leafhopper	Rosy apple aphid	Green apple aphid	Woolly apple aphid	Apple maggot	Leaf curling midge	European red mite	Two-spotted spider mite	Apple rust mite	Apple clearwing moth	Japanese beetle
Nexter																		+++	++	++++		
Perm-Up (M)	++	+++		+++	+R	+++		++	++	+++	+++		++			+++						
Pounce 384 EC (M)	++	+++		+++	+R	+++			+	+++	+++		++			+++						
Rimon 10 EC			++++	++++	++++	++++		++++														
Ripcord 400 EC	+++	+++	+++	+++		+++	+	++	+	+++	+		++			+	++					
Sevin XLR	++	++	+++R	++	+	++	+	++		++	++++		+	+	+	++						++++
Silencer (M)	++	+++	+++	+++	+R	+++	+	+++		+++	++++	++++	+++	++	+	+++	++					
Spray Oil 13 E							++++						++					++++				
Success, Entrust	+		+	++++	++++	++++		+								++					++++	
Superior 70 Oil							++++						++					++++				
Surround	++		+		+		++	+ES		+	++	+				++						+
Up-Cyde 2.5 EC (M)	+++	+++	+++	+++	+R	+++		++		+++	+		++			++	++					
Vydate L					+	+++	+				+++		+++	+++	+			++	+++	+++		
Zolone Flo (M)	+++	+++		+++	+++R		++	+++			++	++	+++	+	+++	+++						

+ Reduction in damage.
++ Suppression.
+++ Good control with some limitations.
++++ Excellent control.
M = May cause mite flare ups.
R = Resistant.
ES = Early season applications only.
Blank cell = Information is unavailable.

Ratings are based on moderate insect or mite pressure. Heavy infestations may require either higher dosage or shorter intervals, or both. Efficacy may be affected by rate of insecticide used, as well as coverage, timing and residual of the product. In some orchards, resistance may cause control failures when present. See *Pest Resistance to Insecticides, Fungicides and Miticides*, page 253. Products must be applied at proper timings and label rates for each pest/. Consult label or apple calendar for this information.

Adapted from Cornell Pest Management Guidelines for Tree Fruit and the Pennsylvania Tree Fruit Production Guide.

Table 4-11. Toxicity of Pesticides to Mite and Aphid Predators

Insecticides	***Stethorus* adults**	***Stethorus* larvae**	***Typhlodromus pyri***	***Amblyseius fallacis***	***Zetzelia mali***	***Aphidoletes***	**Ladybugs**	**Minute pirate bugs**	**Lacewings**	**Fly and wasp parasitoids**
Actara 25 WG	+++	+++	+	0	0	++	+++	++	++	+++
Admire 240 F	++	++	++	++	+	+	++	++	++	++
Ambush 500 EC	+++	+++	+++	+++	++	+	++	++	++	+++
Assail 70 WP	++	++	+	0	0	++	++	++	++	+++
Beleaf 50 SG	0	0	0	0	0	0	0	0	0	0
Bioprotec CAF	0	0	0	0	0	0	0	0	0	0
Calypso 480 SC	++	++	0	0	0	+	++	++	++	+++
Clutch 50 WDG	++	++	+	0	0	+	++	++	++	+++
Confirm 240 F	0	0	0	0	0	0	0	0	0	0
CYD-X	0	0	0	0	0	0	0	0	0	0
Decis 5 EC	+++	+++	+++	+++	++	++	+++	++	+++	+++
Delegate WG	+	+	++	++	+	+	+	+	+	+
Diazinon 50 WSP	+	+	+	+	+	+++	++	+	++	+++
Dipel 2X DF	0	0	0	0	0	0	0	0	0	0
Foray 48BA	0	0	0	0	0	0	0	0	0	0
Imidan 50 WP	+	+	0	0	0	+	++	++	++	+++
Intrepid 240 F	0	0	0	0	0	0	0	0	0	0
Malathion 25 W	+	+	0	0	0	+	++	+	+	++
Matador 120 EC	+++	+++	+++	+++	++	+++	+++	+++	+++	+++
Perm-Up	+++	+++	+++	+++	++	+	++	++	++	+++
Pounce 384 EC	+++	+++	+++	+++	++	+	++	++	++	+++
Rimon 10 EC	0	+++	0	0	0		+++	++	+++	++
Sevin XLR	+++	+++	++	++	++	+++	++	++	++	+++
Silencer 120 EC	+++	+++	+++	+++	++	+++	+++	+++	+++	+++
Success 480 SC	0	0	+	+	0	0	0	0	0	+
Surround WP	++	++	++	++	++		++			++
Virosoft CP4	0	0	0	0	0	0	0	0	0	0
Miticides										
Acramite 50 WS	0	0	++	++	++	+	0	0	0	
Agri-Mek 1.9% EC	++	++	++	++	+	+	+	+	+	
Apollo SC	0	0	+	+	+	0	0	0	0	
Envidor SC	++	++	+	+	+					
Kanemite 15 SC	+	+	+	+	+					
Nexter	++	++	++	++	++	++	++	++	++	
Purespray Green Spray Oil 13 E	+	+	++	++	+	+	+	+	+	
Superior 70 Oil	+	+	++	++	+	+	+	+	+	
Vydate L	++	++	+++	+++	+++	++	++	+++	+++	+++

0 = non toxic + = slightly toxic ++ = moderately toxic +++ = very toxic
Blank cell means information is unavailable.

Adapted from Cornell Pest Management Guidelines for Tree Fruit and the Pennsylvania Tree Fruit Production Guide.

Table 4-11. Toxicity of Pesticides to Mite and Aphid Predators (cont'd)

Insecticides	*Stethorus* adults	*Stethorus* larvae	*Typhlodromus pyri*	*Amblyseius fallacis*	*Zetzelia mali*	*Aphidoletes*	Ladybugs	Minute pirate bugs	Lacewings	Fly and wasp parasitoids
Fungicides										
Captan 80 WDG	+	+	+	+	+					
Flint 50 WG	+	+	0	0	0					
Inspire	+	+	+	+						
Manzate Pro-stick	+	+	++	++	+					
Microthiol Disperss	++	++	++	++	+					
Nova 40 W	+	+	0	0	0					
Penncozeb 75 DF	+	+	++	++	+					
Polyram DF	+	+	++	++	+					
Sovran	0	0	0	0	0					
Vangard 75 WG	0	0	0	0	0					

0 = non toxic + = slightly toxic ++ = moderately toxic +++ = very toxic
Blank cell means information is unavailable.

Adapted from Cornell Pest Management Guidelines for Tree Fruit and the Pennsylvania Tree Fruit Production Guide.

Notes on Apple Diseases

Apple scab

Primary infection periods

Once the tree breaks dormancy and green tissue is present, a primary infection occurs if the following three conditions are met:

1. mature ascospores are present in leaf litter in the orchard
2. weather conditions favour ascospore discharge and infection
3. fungicide protection is inadequate to prevent infections

Mature ascospores are always present in infected overwintering leaves at bud break. The number of ascospores present depends on the amount of inoculum in the overwintering leaves. The rate ascospores mature in the overwintering leaves on the orchard floor is mainly determined by temperature.

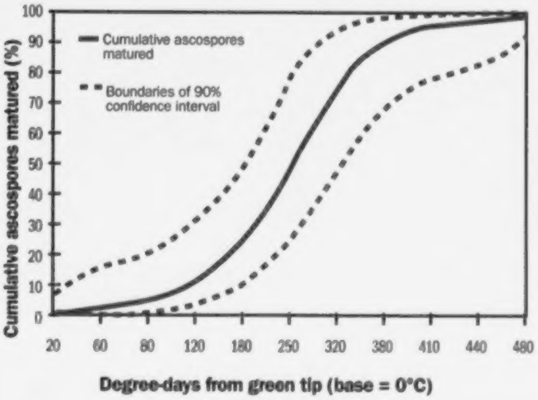
Researchers at Cornell University have developed a model that relates temperature to ascospore maturation. The model is expressed in degree-days Celsius (DDC) and allows you to predict the percentage of the season's ascospores that have matured. For further information, see Figure 4-2. *Cumulative Percentage of Ascospores Matured at Various Degree-day Accumulations,* page 65. Daily accumulated degree-days are calculated as follows:

$$\text{DDC} = \frac{(\text{Daily max }^\circ\text{C})+(\text{Daily min }^\circ\text{C})}{2} - 0^\circ\text{C}$$

For example, on a day with a high of 10°C and a low of 2°C, the accumulated degree-days are six DDC. If either of the daily temperatures is below 0°C, i.e. a negative number, then use a value of zero for that temperature. Begin degree-day accumulations at bud break, which is defined as the day on which at least 50% of the fruit buds on McIntosh are between silver tip and green tip.

Use the degree-day accumulations to estimate the percentage of mature ascospores from the central curve in Figure 4-2. *Cumulative Percentage of Ascospores Matured at Various Degree-day Accumulations,* page 65. The upper and lower curves are the upper and lower 90% confidence limits around the estimates on the graph. The estimate should fall within this range 90% of the time.

Figure 4-2. Cumulative Percentage of Ascospores Matured at Various Degree-day Accumulations



Two points of particular interest on this graph are:

- At 125 DDC, there is a rapid maturation of ascospores that indicate higher risk of infections.
- At 418 DDC, over 95% of the ascospore supply should be depleted if sufficient rain has occurred. This marks the end of the primary infection season. With this model, growers can obtain a site-specific forecast of ascospore maturity and discharge for their own orchard(s).

Ascospores are released when there is rain to wet the pseudothecia in the dead leaves. Most of the available mature spores are discharged within two hours after the start of rain. Ascospore release is strongly light dependent and only a small percentage of available ascospores are released at night from 7:00 p.m. to 8:00 a.m. Eastern Daylight Savings Time (EDST).

In **low inoculum** orchards ascospores are not released to any significant extent during night-time hours. In an orchard where the ascospore inoculum is **high**, although the percentage of ascospores released is small at night, the total number of ascospores released is large and can result in a significant primary scab infection. If scab was present in the orchard the previous season, consider the orchard to have high inoculum.

In a low-inoculum orchard, calculate the length of the wetting period using the following method:

- When rain begins during the day, between 8:00 a.m. and 7:00 p.m. EDST, count the hours of leaf wetness from when the first hour rain was recorded until the leaves are dry.
- When rain begins at night, between 7:00 p.m. and 8:00 a.m. EDST, count the hours of leaf wetness from 8:00 a.m. in the morning until the leaves are dry.

For a high-inoculum orchard, calculate the length of the wetting period from the start of the rain until the leaves are dry, regardless of the time of day. In high-inoculum orchards if a rain event starts during the day, continue counting the hours of leaf wetness even after nightfall.

Rainfall is needed for the release of ascospores and the leaves and fruit must be wet for infection to occur. The length of the wetting period required for infection varies with temperature. The relationship between hours of wetting and temperature is outlined in Table 4-12. *Relationship of Temperature and Moisture to Apple Scab Infection,* on this page.

Table 4-12. Relationship of Temperature and Moisture to Apple Scab Infection

Average temp. (°C)	Minimum number of hours of leaf wetness required	
	Primary season (ascospore infection)	Secondary season (conidia infection)
1	40	37
2	34	33
4	27	26
5	21	23
6	18	20
7	15	17
8	13	15
9	12	13
10	11	12
11	9	10
12	8	9
13	8	9
14	7	9
15	7	9
16	6	9
17	6	8
18	6	8
19	6	8
20	6	7
21	6	7
22	6	7
23	6	8
24	6	9
25	8	11
26	11	14

Adapted from: Stensvand, Gadoury, Amundsen, Semb and Seem, 1997 Phytopathology 87: 1046-1053.

Once the length of the wetting period is determined, calculate the average temperature during this interval and check Table 4-12. *Relationship of Temperature and Moisture to Apple Scab Infection,* page 65, to see if leaves were wet long enough for an infection to occur.

Once a primary infection occurs and primary lesions are present, then secondary infections can occur. Initially lesions can be very difficult to see. As a result, scouting and maintaining adequate fungicide coverage is very important.

Secondary infection periods

Secondary scab infections occur when splashing rain spreads conidia, developed from primary scab lesions, on leaves. Secondary infections only occur if moisture from rain is present long enough at a given temperature. Since secondary infections can occur day or night, calculate from the beginning of the wetting period, regardless of time of day.

Effect of intermittent rain and dew on infection periods

Periods of dew or high humidity (over 90%) also contribute to a wetting period, but are significant only if preceded by rain. Add together wet periods caused by intermittent rain to determine the length of an infection period, unless wet periods are separated by 10 hours or more of dry, sunny weather.

Fruit infection

As the fruit matures it takes a longer wetting period for infection by apple scab to occur. Refer to OMAFRA Publication 310, *Integrated Pest Management for Apples* or *Ontario CropIPM: Integrated Pest Management Training* available on the OMAFRA website *www.ontario.ca/cropIPM* or in OMAFRA Publication AF141 (CD format) for more information.

Reducing apple scab inoculum

While growers have little control over weather conditions, they can reduce inoculum and ensure adequate fungicide protection. The following methods will reduce inoculum in orchards.

The application of urea (45 kg of agricultural urea per 1,000 L of water/ha) to the orchard floor after about 95% leaf drop (November) or in the spring (April) before bud break reduces the number of ascospores. The urea works in two ways. It directly inhibits the development of ascospores, and it stimulates the growth of naturally occurring organisms that are antagonistic against the fungus that causes apple scab, *Venturia inaequalis.* In most years the spring treatment is more effective and results in fewer leaf and fruit infections. When snow cover remains until bud break there is little time for the urea to work, and the treatment is less effective.

Shredding overwintering leaves using a flail mower can also reduce primary inoculum. Rake or blow leaves from under trees and shred them using a flail mower. Shredded leaves decay more quickly.

Management of apple scab with fungicides

Early season management

Management programs for primary apple scab infection are based on the timing and type of fungicide used. There are two general approaches. Apply fungicides as a protectant program before infection occurs, or apply fungicides after infection but before symptoms develop.

Fungicides are applied to expanding foliage before infection periods occur. Apply fungicides when conditions for infection are imminent. Begin fungicide programs between silver tip and green tip. From first cover until early August, apply fungicides at 10–14 day intervals depending on rainfall frequency. New growth and expanding fruit must be protected and residues washed off by rain must be replaced. The exception to this is when using fungicides in the DMI group (Nova, Nustar, Inspire). Use a 5–7 day spray schedule regardless of rainfall. DMI fungicides are weak on fruit scab, do not start a DMI program after bloom. Some fungicides are not readily washed off and the residues are redistributed by rainwater. See Table 4-13. *Characteristics of Apple Scab Fungicides,* page 67.

There are several different fungicide groups available for use in apples. See Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action,* page 257. For more information on these fungicides refer to OMAFRA Publication 310, *Integrated Pest Management in Apples.* For information on resistance management strategies with these products refer to *Managing resistance to fungicides,* page 254 and *Resistance management strategies by fungicide group and disease for Ontario fruit crops,* page 254.

Control of apple scab under adverse weather conditions

Several consecutive days of continually wet conditions and mild temperatures are common in the spring. These conditions encourage apple scab infection. It is often difficult to maintain sufficient fungicide on the trees to provide protection for the rapidly expanding foliage and fruit under such conditions.

If there is concern about adequate protection, it is better to apply a protectant-type fungicide during a break in the rain than to not spray at all. Be sure to use a fungicide with good retention properties. For example, products with mancozeb such as Dithane, Manzate and Penncozeb have good retention activity.

After-infection sprays may be required when protectant fungicides become too diluted to prevent the apple scab fungus from establishing itself on the foliage or fruit.

If an infection exists, scab lesions become visible on the foliage and fruit in about nine days at 20°C or in about 14–21 days if the average temperatures are 12°C or lower. Once this occurs, avoid using fungicides with high potential for resistance (DMI's, strobilurins) and focus on protecting uninfected tissue from further infections.

Strong winds can hamper spray operations by causing pesticides to drift away from the intended target. Spray at night or early morning to help reduce spray drift. You can also lower the spray trajectory into the wind to minimize drift, but take extra care to ensure the treetops get good spray coverage.

Secondary scab management

The end of primary season can be determined through use of the degree-day model. At 418 DDC, over 95% of the ascospores are mature, and after a significant rain all of the ascospores have been discharged for the season. After this point, wait two weeks and then check the trees for scab. It can take up to 14 days for lesions to appear after a scab infection period. Be sure to check the top of standard trees or anywhere else spray coverage may not have been adequate, such as a thick tree canopy.

If primary scab was controlled, the rates of fungicides may be reduced and the interval between sprays may be lengthened for the remainder of the growing season. Some growers have successfully eliminated all use of fungicides during the summer months where primary scab was controlled. If scab lesions are found, maintain a fungicide program for the remainder of the season.

Choosing a fungicide

Use the information in the following tables to assist with choosing the best product for the most likely diseases. Consider the history of the disease, resistance

Table 4-13. Characteristics of Apple Scab Fungicides

Product	Protectant activity (pre-infection)	Maximum after-infection activity calculated from the start of the infection period (hr)			Post-symptom activity	Retention (50 mm rain)	Re-distribution (12 mm rain)
		6°C	12°C	17°C			
Captan 50 WP	VG	48	24	18	N	VG	G
Dithane M 45/80 WP	VG	48	24	18	N	E	VG
Flint 50 WG	E	96[3]	96[3]	96[3]	E	E	F*
Manzate 200	VG	48	24	18	N	E*	VG
Nova 40 W[2]	F	96	96	96	FG	F*	F*
Nustar	F	96	96	96	E	E	
Polyram 80 WP	VG	48	24	18	N	E*	VG
Scala SC	G	72		48	N	G	
Sovran	E	96[3]	96[3]	96[3]	E	E	F*
Vangard 75 WG	G	24		18	N	G	

Data is adapted from New York (Geneva) from work done by Szkolnik et al, using conidia. These values are adapted from greenhouse tests on Golden Delicious. The after-infection activity of these fungicides may not be adequate to control primary scab in commercial orchards. Do not rely solely on after-infection activity for the control of apple scab.

These results are formulation specific. Newer products and formulations of some products have not been evaluated (e.g. Allegro 500 F, Dithane DG, Inspire, Polyram DF, Manzate 200DF and Pristine WG). Contact the manufacturer for more information.

[1] Maximum after-infection activity is calculated from the start of the infection period.

[2] Data on Nova is adapted from *1993 Pest Management Recommendations for Commercial Tree Fruit Production*, Cornell Cooperative Extension, New York.

[3] After-infection activity of DMI (Nova and Nustar) and QoI (Flint and Sovran) fungicides may be reduced in orchards where scab populations have shifted toward resistance to DMI fungicides.

Blank cell means information is unavailable.

KEY: E = excellent; VG = very good; G = good; F = fair; P = poor; N = none. Values followed by '*' are based on field observations.

management strategies, as well as the activity of each product to diseases, and the weather. See Table 4-13. *Characteristics of Apple Scab Fungicides,* page 67 and Table 4-14. *Activity of Fungicides on Apple Diseases,* on this page.

Fungicide resistance

For more information see, *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253 and *Resistance Management Strategies,* page 253.

Table 4-14. Activity of Fungicides on Apple Diseases

Ratings in shaded cells indicate the pest is listed on the product label for control or suppression. Use fungicides only for the disease listed on the product label for the crop. Where ratings are not in shaded cells, some activity against this disease is anticipated, but this use is not on the product label. Consult the label for more information. The information provided in this table is intended to assist the grower in choosing the best fungicide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product or by the presence of resistant populations. See *Resistance management strategies by fungicide group and disease for Ontario fruit crops,* page 254.

Group	Fungicide	Apple scab	Powdery mildew	Rust	Black rot	Bitter rot	Sooty blotch	Fly speck
M	Copper 53 W	+	+	+	+	+	+P	+P
M	Kumulus DF	+	++	+	0	0	0	+
M	Microscopic Sulphur	+	++	+	0	0	0	+
M	Microthiol Disperses	+	++	+	0	0	0	+
M	Dithane DG	+++	0	++	0	NA	+++	+++
M	Manzate Pro-Stick	+++	0	++	0	NA	+++	+++
M	Penncozeb 75 DF	+++	0	++	0	NA	+++	+++
M	Polyram DF	+++	0	++	0	NA	+++	+++
M	Supra Captan 80 WDG	+++	0	0	+++	++	+	+
M	Maestro 80 DF	+++	0	0	+++	++	+	+
M	Ferbam 76 WDG	+	0	++P	+	+	+	0
3	Inspire	+++	+	+++	0	0	+++	+++
3	Nustar	+++	++	+++	0	0	0	0
3	Nova 40 W	++	+++	+++	+	0	0	0
7+11	Pristine WG	+++	+++	+	+++	+++	+++	+++
9	Vangard 75 WG	++	+	0	0	NA	0	0
9	Scala SC	++	0	NA	NA	NA	NA	NA
11	Sovran	+++	++	+	+++	++	+++	+++
11	Flint 50 WG	+++	++	+	+++	++	+++	+++
29	Allegro 500 F	++	0	0	0	0	+++	+++
	Purespray Green Spray Oil 13E	0	+	0	0	0	0	0

P = Phytotoxic, causes russeting.
0 = No control.
NA = Not applicable because the fungicide is not applied at the timing for this pest.
+ = Poor to fair control; ++ = Good control, some limitations; +++ = Excellent control, few if any limitations.
Source: various extension publications and Plant Disease Management Reports (APS).

Thinning and Plant Growth Regulators

Chemical thinning of apples

Thinning of apples will:

- improve average fruit size and finish
- create more uniformity in the crop
- encourage return bloom and annual bearing

The objective of thinning is to reduce clusters to single fruitlets on most cultivars, preferably the king bloom fruitlet, and to adequately space fruit to every other bearing spur. An additional benefit of thinning is reduced probability of pest damage. Some pests are more likely to damage clustered fruit.

Early thinning is important. Thinning near bloom or shortly afterward will increase average fruit size and maximize return bloom the next year.

Grower experience is the best guide to thinning needs, so it is important to document the previous thinning history including rates, conditions at time of application, and results. Other factors include:

- the cultivars involved
- fruit sizes required
- strength of bloom
- bee activity
- weather conditions during pollination and following fruit set

Compared to a tree with an excessive crop load, a well-thinned crop has better colour and is more efficient to harvest, which reduces labour costs per bin.

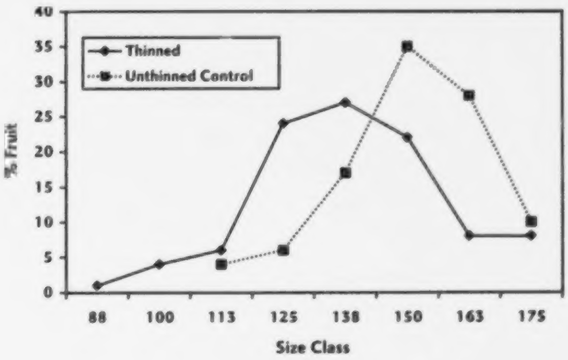
Fruit size distribution in the tree canopy

When you compare a well-thinned apple tree of any cultivar to a tree that is insufficiently thinned, several factors become obvious.

- Size distribution of fruit within the canopy of both trees follows a normal distribution pattern. See Figure 4-3. *Comparison of Thinning Effects on Fruit Size Distribution in the Tree Canopy,* on this page.
- Other factors being equal, the average fruit size from the thinned tree is greater than that of an unthinned tree.
- While adequate thinning typically reduces yield, the value of the thinned crop more than compensates for any loss in yield provided the tree is not over-thinned.

In other words, where the fruit volume of thinned and unthinned trees is similar, the thinned tree has fewer apples but they are of greater size and higher value. See Table 4-15. *Effect of Apple Fruit Size on Tray and Bin Requirements,* on this page, for a comparison of fruit numbers of different size classes required to fill a standard apple bin. See Table 4-16. *Effect of Fruit Size in Relation to Crop Load,* page 70, to determine how much thinning is required.

Figure 4-3. Comparison of Thinning Effects on Fruit Size Distribution in the Tree Canopy



This figure shows how the distribution of fruit size classes is similar on thinned and unthinned Empire trees. Note that thinning pushes the size distribution to the larger size classes. There was less than 10% difference in total yield between the two treatments.

Table 4-15. Effect of Apple Fruit Size on Tray and Bin Requirements

	Minimum size			Number of apples per bin[2]
Tray Size	wt (g)[1]	inch	mm	
196	102	2 ¼	57	3,920
175	114	2 ⅜	60	3,500
163	123	2 ½	64	3,260
150	133	2 ⅝	67	3,000
138	145	2 ¾	70	2,760
125	160	2 ⅞	73	2,500
113	177	3	76	2,260
100	200	3 ⅛	79	2,000
88	227	3 ¼	83	1,760
80	250	3 ⅜	85	1,600
72	278	3 ½	89	1,440
64	313	3 ⅝	92	1,280
56	357	3 ¾	95	1,120
48	417	3 ⅞	98	960

[1] These values are approximate as fruit of the same diameter can differ in weight.

[2] 18-bushel bin capacity.

Table 4-16. Effect of Fruit Size in Relation to Crop Load

Minimum size		Number of apples required per tree for given tree density, desired yield and fruit size					
		Tree density (trees per acre)					
		272		500		1,000	
		Projected yield (Bu/ac)					
in	mm	400	600	500	750	750	1250
2 ¼	57	320	480	218	327	163	272
2 ⅜	60	286	429	194	292	146	243
2 ½	64	266	400	181	272	136	226
2 ⅝	67	245	368	167	250	125	208
2 ¾	70	225	338	153	230	115	192
2 ⅞	73	204	306	139	208	104	174
3	76	185	277	126	188	94	157
3 ⅛	79	163	245	111	167	83	139
3 ¼	83	144	216	98	147	73	122
3 ⅜	85	131	196	89	133	67	111
3 ½	89	118	176	80	120	60	100
3 ⅝	92	105	157	71	107	53	89
3 ¾	95	92	137	62	93	47	78
3 ⅞	98	78	118	53	80	40	67

Steps in thinning

1. Determine how much thinning is required through an evaluation of the orchard factors and an assessment of fruit load potential. Sepals or calyx leaves on unpollinated blooms tend to stay open or bend back. Successful pollination and fruit set results in sepal movement and closure.

2. Determine the material to use and the concentration or strength of the thinner required.

3. Determine the water volume required to effectively wet the trees. High water volumes that wet the foliage to the point of runoff are recommended for chemical thinners. The average tree on M.26 (3–3.5 m tall) at a density of 720 trees per ha may require more than 2 L of spray per tree to thoroughly wet the foliage at the time of the thinning. As the tree size becomes smaller and the number of trees per ha increases, the volume of canopy that must be sprayed may become less. Calibrate the sprayer and water volumes on small groups of trees to determine just how much water is required to thoroughly wet individual trees. See *Carrier volume*, page 234 and OMAFRA Factsheet, *Adjusting, Maintaining and Cleaning Airblast Sprayers* – Order No. 10-069.

Sampling method to determine timing

Collect 50–60 fruitlets of each cultivar to provide a good estimate of fruit development in a reasonably uniform orchard block. Select the two largest developing fruits from each of 25–30 randomly selected clusters. Measure the greatest diameter of each using Vernier calipers or a thinning template and determine the average for the sample.

Chemicals available for thinning

MaxCel or Cilis Plus (6-BA)

Product Name: MAXCEL or CILIS PLUS.
Active ingredients: 1.9% 6-benzyladenine (6-BA).
Type of thinner: A growth regulator containing a cytokinin (6-BA) that promotes cell division.
How it works: Used for both fruit thinning and improving fruit size. Fruit size potential is increased due to increased cell division shortly after flowering in the early stages of fruit growth and development.
Rate: To increase fruit size, make 2–4 applications at 10–50 ppm, beginning at petal fall and repeating every 3–10 days. Some easy-to-thin cultivars may also be thinned.

To thin fruit apply at 75–200 ppm (MaxCel or Cilis Plus at 100–150 ppm will provide more thinning than Accel at the same rate due to the absence of gibberellic acid.) See Table 4-17. *Suggested Rates of MaxCel or Cilis Plus to Use With or Without Sevin*, page 71.

Application: Dilute MaxCel or Cilis Plus in 500–2,000 L of spray solution per ha. Uniform and thorough coverage is essential. Use enough water to wet the foliage just to the point of runoff. See Table 4-18. *The Relationship Between Spray Water Volumes,*

Table 4-17. Suggested Rates of MaxCel or Cilis Plus to Use With or Without Sevin

Desired Response[1]	Concentration of 6-BA (ppm)[2]	Concentration rate of carbaryl (ppm)[2]	Number of Applications	Amount of MaxCel per 1,000 L water. Apply to 1 ha	Amount of Sevin XLR Plus per 1,000 L water. Apply to 1 ha
Enhance size only[3,4]	10–50	–	2 to 4	0.5–2.5 L	–
Mild thinning and sizing	50–75	–	1 to 2	2.5–3.75 L	–
Moderate thinning and sizing	75–100	–	1 to 2	3.75–5 L	–
	50–75	500	1 to 2	2.5-3.75 L	1 L
Aggressive thinning and sizing	100–150	–	1 to 2	5–7.5 L	–
	75–100	500–1,000	1 to 2	3.75–5 L	1–2 L
Very aggressive thinning and sizing	150–200	–	1 to 2	7.5–10 L	–
	100–125	1,000	1 to 2	3.75–5 L	2 L

[1] There are several factors that influence the chemical thinning outcome. Rates are generally chosen on the degree of cultivar sensitivity to chemical thinners. See *Cultivar notes*, page 75 for further information on cultivars sensitivity to chemical thinners.

[2] 1 ppm is equivalent to 1 mg/L.

[3] Mild thinning may occur under some conditions (weak trees, young trees, sensitive cultivars, and environmental conditions that favour the thinning response).

[4] While 6-BA has the potential to increase cell division and enhance fruit size beyond the thinning (crop load) effect alone, this is not observed in all years because the response can be affected by spray concentration, coverage, cultivar, tree health, time of application, tree stress, and environmental conditions during and following spray application.

Grams Active Ingredient (6-BA) per Hectare, Litres of Product per Hectare and Final Tank Concentration of MaxCel or Cilis Plus, on this page.

Cultivar Notes: Recommended for Empire, McIntosh, Idared, Gala and others; not effective on all cultivars. See Table 4-19. *Suggested Rates for Chemical Thinning of Mature Apple Trees*, page 73.

Timing: For thinning, these products are most effective when fruitlets are 5–15 mm in diameter. For fruit size, begin applications at petal fall.

Repeat Applications: Apply a maximum of two sprays per season for thinning, or four applications to improve fruit size.

Optimum conditions: Best results are obtained when temperatures greater than 20°C occur during and after application. Slow drying conditions are preferred (e.g. early morning).

Precautions: Preharvest interval is 86 days. Do not apply MaxCel or Cilis Plus in combination with NAA (naphthaleneacetic acid) or NAD (naphthaleneacetamide) either as a tank-mix or

Table 4-18. The Relationship Between Spray Water Volumes, Grams Active Ingredient (6-BA) per Hectare, Litres of Product per Hectare and Final Tank Concentration of MaxCel or Cilis Plus[1]

Spray volume required (litres/ha)	Rate of MaxCel or Cilis Plus						
	grams 6-BA/hectare						
	10	25	50	75	100	200	446
	litres of product per hectare						
	0.5	1.3	2.5	3.8	5	10.1	22.4
	concentration of 6-BA (mg/L or ppm)						
200	50	125	250	375	500	1,000	2,230
300	33	83	167	250	333	667	1,487
400	25	63	125	188	250	500	1,115
500	20	50	100	150	200	400	892
600	17	42	83	125	167	333	743
700	14	36	71	107	143	286	637
800	13	31	63	94	125	250	558
900	11	28	56	83	111	222	496
1,000	10	25	50	75	100	200	446
1,500	7	17	33	50	67	133	297
2,000	5	13	25	38	50	100	223

[1] Concentrations of 6-BA in shaded area are not effective (for either sizing or thinning).

separate sprays during the same growing season. These combinations may result in pygmy fruit in Delicious and Fuji.

NAD (naphthaleneacetamide)

Product name: AMID THIN.

Active ingredient: NAD (naphthaleneacetamide).

Type of thinner: A hormone-type material.

How it works: Absorbed by foliage where it induces formation of the abscission layer between the spur and the fruitlet. Mostly absorbed from the original spray solution, not from re-wetting.

Timing: Apply NAD at first petal fall when petals on the king blossom are falling.

Rate: Use concentrations of 50–100 ppm, depending on variety and growing conditions. NAD is particularly effective on hard-to-thin varieties such as Golden Delicious, if used at the proper time. See Table 4-19. *Suggested Rates for Chemical Thinning of Mature Apple Trees,* page 73.

Optimum Conditions: Best applied at temperatures between 21°C and 24°C, under slow drying conditions, as NAD is mostly absorbed from the original solution. Once dry, the effect it has on thinning is over. Apply in enough water to ensure thorough coverage and slow drying. Absorption increases when weather promotes soft, succulent and rapid growth. Avoid windy, cool, fast drying conditions.

Precautions: NAD is a relatively safe thinner, in that it seldom over-thins. Do not apply during the same growing season as MaxCel or Cilis Plus, or pygmy fruit may result.

NAA (naphthaleneacetic acid)

Product name: FRUITONE-N.

Active Ingredient: NAA (naphthaleneacetic acid).

Type of thinner: A hormone-type thinner.

How it works: Absorbed primarily through the leaves from the solution. Mostly absorbed from original spray solution, not from re-wetting. NAA has a short life due to breakdown by sunlight. NAA affects auxin activity, and interferes with photosynthesis and proper fruit development. Affected fruitlets usually drop within 10–14 days. NAA can result in leaf flagging (wilting) but these leaves recover in a few days.

Rate: 5-20 ppm. See Table 4-19. *Suggested Rates for Chemical Thinning of Mature Apple Trees,* page 73.

Timing: Apply up to 12 days after petal fall. NAA applied too soon, in the bloom to petal fall period, can result in excessive thinning of Empire.

Application: Use larger volumes of water under slow drying conditions. NAA is considered to be rainfast after 2–3 hours.

Mixing: May be mixed with carbaryl (Sevin).

Optimum Conditions: Warm, dull, slow drying conditions are preferred to maximize absorption of NAA. Morning is the preferred time when trees are damp, drying is slow and temperature is on the rise. Once the material is absorbed, the tree has the day to respond to the thinner. NAA is not effective at temperatures less than 10°C.

Precautions: Do not apply during the same growing season as MaxCel or Cilis Plus, or pygmy fruit may result.

Carbaryl (Sevin)

Product name: SEVIN XLR.

Active Ingredient: Carbaryl.

Type of thinner: An insecticide that also causes fruit thinning after petal fall.

How it works: Carbaryl is absorbed primarily through the fruit, not the foliage. The presence of carbaryl in the vascular system of the fruitlet interferes with biochemical processes. Certain important fruit growth processes cease and the fruitlet drops. This fruitlet drop usually starts 5–10 days after application.

Rate: 0.5–2 L product per 1,000 L water. See Table 4-19. *Suggested Rates for Chemical Thinning of Mature Apple Trees,* page 73. Thinning with Sevin increases as concentrations rise up to 1 kg of active carbaryl (2 L of Sevin XLR) per 1,000 L of water. There may be little or no increase in thinning with higher concentrations. One litre of Sevin XLR contains approximately the same amount of active ingredient (carbaryl) as 1 kg of Sevin 50 W.

Note: Sevin XLR does not provide additional thinning effects when rain or dews cause re-wetting (as was common with Sevin 50 W).

Note: Because carbaryl is relatively insoluble in water and quickly saturates the spray solution, exceeding this rate of 2 L product/1,000 L water will not increase thinning. Only the carbaryl in true solution will cause thinning. This also reduces the risk of over-thinning.

Timing: Preferred timing is 7–12 days after petal fall (7 days when warm and 12 days when cool). Can be applied up to 21 days after petal fall if conditions are less than ideal.

Application: Apply as a separate dilute spray to thoroughly cover the trees and developing fruitlets. A 3–3.5 m tall, semi-dwarf tree on M.26 may require more than 2 L of spray to thoroughly wet the foliage.

Mixing: May be tank-mixed with NAA, MaxCel or Cilis Plus.

Optimum Conditions: Best applied at temperatures between 21–24°C, under slow drying conditions.

Precautions: Sevin can be harsh on beneficial insects and mite predators. Remove bees from orchard and surrounding fields before applying Sevin as it is very toxic to bees.

Table 4-19. Suggested Rates for Chemical Thinning of Mature Apple Trees[1]

Cultivar	NAD ppm[2]	NAA ppm[2]	Sevin XLR L/1,000 L[3]	Sevin XLR +NAA ppm/1,000 L water[2,3]	MaxCel or Cilis Plus (g BA/ha)[4]	Sevin XLR (L/1,000 L water)[2,3] + MaxCel or Cilis Plus (g BA/ha)[4]
Lodi, Melba, Quinte, Yellow Transparent	50–75	—	—	1 L + 10–15 ppm	—	—
Early McIntosh	75–100	—	—	1 L + 5–10 ppm (at petal fall)	50–75	—
Jerseymac, VistaBella, Tydeman's Red	—	5–10	1–1.5	—	—	—
Paulared	50–75	12–15	1–1.5	1 L + 10–15 ppm	75	1 L + 50
Spartan, Russets	—	10–20	1–2	1 L + 10–15 ppm	—	—
Cortland	—	5–10	—	1–2 L + 2.5–5 ppm	—	—
Ambrosia	—	—	1–1.5	—	50	—
Aurora Golden Gala™	—	—	1-1.5	—	75	1 L + 50
Silken	—	—	1–1.5	—	—	—
Cameo	—	—	1	—	—	—
Creston	—	—	0.5–1	—	—	—
Non-spur McIntosh	—	5–10	1–2	—	50	—
Spur-type McIntosh	—	10–12	—	1–2 L + 2.5–5 ppm	50–75	1 L + 50
Golden Delicious, Wealthy	75–100	10–20	1–2	1 L + 5–10 ppm	75–100	1–2 L + 50
Golden Supreme	—	—	1	—	—	—
Goldrush	—	—	—	1 L + 10 ppm	—	—
Red Delicious	—	2–8	0.5–1.5	—	—	—
Spur-type Red Delicious	—	5–10	—	1–2 L + 5–10 ppm	—	—
Idared	—	2–8	—	—	50–75	—
Empire	—	7–10	1–1.5	1 L + 2.5–4 ppm	50–100	1 L + 50
Spy, Mutsu/Crispin	—	5–10	0.5–1.5	—	—	—
Jonagold	—	—	1–1.5	—	50–75	—
Fuji	—	—	—	1–1.5 L + 10–12 ppm	100–150	1–2 L + 50–75
Gala	—	10–12	—	1 L + 5–10 ppm	75–100	1–2 L + 50
Honeycrisp	—	5	1–1.5	1 L + 2.5 ppm	—	—
Gingergold	—	7–10	1–1.5	1 L + 2.5–5 ppm	75	1 L + 50

— Indicates treatment recommendation not available.

[1] These rates are suggested for trees with a settled cropping history. Chemically thinning a first crop tree or immature trees is considered very risky.

[2] Sufficient water volumes must be used to thoroughly wet trees. See *Steps in thinning,* page 70.

[3] Note: The rates for Sevin are amounts of product. Sevin XLR is 43% active ingredient and contains 480 g or approximately 0.5 kg of carbaryl per litre. 1 L of Sevin XLR is roughly equivalent to 1 kg of Sevin 50 W. For actual amounts of NAD and NAA refer to the label of the product being used.

[4] Consult Table 4-17. *Suggested Rates of MaxCel or Cilis Plus to Use With or Without Sevin,* page 71, to determine the actual ppm benzyladenine (BA) being applied. Concentration of BA should be no less than 50 ppm to be effective.

Carbaryl (Sevin) + NAA

This combination has been used successfully on hard-to-thin cultivars such as Paulared, Golden Delicious, Fuji and Gala strains. Use a constant rate of 1 L Sevin XLR (product) per 1,000 L of water with varying rates of NAA from 3–15 ppm. Since NAA only has one chance to work, use high water volumes.

Sevin + MaxCel or Cilis Plus

Combination sprays of Sevin and 6-BA are required for difficult-to-thin cultivars or for situations where aggressive thinning is required to decrease crop load to improve final fruit size.

Calculating Parts per Million (ppm)
1 ppm = 1 g active ingredient
per 1,000 L water

Precautions

Do not apply MaxCel or Cilis Plus in combination with the hormone thinners NAA (naphthaleneacetic acid) or NAD (naphthaleneacetamide) either as a tank-mix or separate sprays during the same growing season. Doing so may result in pygmy fruit.

Bee Warning

When Sevin is used in fruit thinning, extensive bee kills can occur if weeds or legumes are blooming in the ground cover. To minimize bee kills, remove bees from the orchard prior to treatment. Do not spray when the wind will carry Sevin to adjacent weedy or crop areas in bloom. Sevin XLR is much safer to use than Sevin 50 W around honeybees. Advise local beekeepers of your spray activity.

Factors influencing response to thinning agents

Length of wetting period and temperature for material absorption

Higher temperatures allow plants to absorb thinning materials more quickly. Optimum temperatures for absorption are in the 20–25°C range. At these temperatures, drying time is usually much faster than early morning or evening when temperatures are 10–15°C cooler. Under cooler conditions, absorption is slower and stretches over a longer period or until the canopy dries.

The total amount of thinning chemical absorbed by the tree canopy appears to be more or less equal regardless of drying time (i.e. warm temperatures and fast drying, or cool temperatures and slower drying). Time of day for application of thinners is not a critical factor. Research on selected cultivars suggests minimal differences in success based on timing of sprays during day or night. However, early morning or evening sprays will reduce the likelihood of blowing thinners off-target since winds tend to be calmer.

Cultivar sensitivity (mature trees)

Easy-to-thin or easy-to-over-thin cultivars include Ambrosia, non-spur Red Delicious, Idared, Mutsu/Crispin, Jonagold strains, Jerseymac, Honeycrisp, Gingergold, Silken, Creston, Cameo and Golden Supreme.

Moderately difficult cultivars include Empire, McIntosh, Northern Spy, and Cortland.

Harder-to-thin cultivars include Golden Delicious, Paulared, Gala strains, Fuji, Goldrush, Spartan, Wealthy, spur-type McIntosh and spur-type Red Delicious.

Weather conditions

These weather conditions encourage absorption of chemical thinners which may increase the thinning response:

- cool, wet weather and low light conditions before or after application
- prolonged period of high humidity without rain, either before or after application
- high temperatures after cool periods
- frost or near-freezing temperatures before or shortly after application
- prolonged period of dry weather before or after application
- excessively warm conditions following fruit set

A decrease in thinning response can result from sunny and warm daytime temperatures accompanied by relatively cool nighttime temperatures before and after thinning treatments have been applied. This results in a high net accumulation of carbohydrate reserves in the tree.

Pollination and bee activity

Pollination and bee activities are closely tied with weather conditions. Pollination conditions and bee populations can make fruit either more or less difficult to thin. Fruit set under good pollination conditions, which results in increased seed count, is harder to thin. Fruit set on king blossoms is more difficult to thin than fruit set on side blossoms. Single fruit are more difficult to thin than clustered fruit. Even a light or spotty set with clustered fruit should be thinned, in order to break up the clusters.

Tree age and vigour

- Young trees are more easily thinned than mature trees that have cropped well for 2–3 years, so hand thinning young trees of high-value cultivars is recommended. Even low rates of thinners that work on mature trees can easily over-thin young trees.

- Mature trees with winter-injured buds, or trees that are low in vigour, are more easily thinned.

- Trees bearing a heavy crop one year with good bloom the next year may be more easily thinned.

- The heavier the bloom, the more stress on the tree and the easier to thin. Producing flowers and pollen requires nitrogen and adds stress to the tree.

- Stress from the previous season makes a tree easier to thin (e.g. excessively dry, excessively wet, nutritional deficiencies, insect or disease injuries).

Density of foliage

- Poorly pruned dense trees are thinned more easily than well-pruned open trees with stronger fruit buds.

- Partially shaded spurs on low branches of well-pruned trees thin more easily than upper spurs.

- Late thinning sprays require increased water volumes for adequate coverage of the rapidly developing tree canopy.

Spray coverage

As with all plant growth regulators, complete coverage is essential for good results. Chemical thinners will act only where deposited.

Timing of application

- Application timings vary with the chemical used. See *Chemicals available for thinning*, page 70, and notes on timing for each product. Petal fall is an important stage for making thinning decisions. Petal fall is when 80% of the petals have fallen but before calyx lobes are closed.

- **NAD:** Apply at early petal fall. See *NAD (naphthaleneacetamide)*, page 72.

- **NAA:** Apply up to 12 days after petal fall. Avoid bloom to petal fall sprays on Empire due to excessive thinning of Empire. See *NAA (naphthaleneacetic acid)*, page 72.

- **Sevin:** Apply up to 21 days after petal fall. See *Carbaryl (Sevin)*, page 72.

- **Sevin + MaxCel** or **Cilis Plus,** and **NAA + Sevin:** Apply 7–12 days after petal fall (7 days if warm, 12 days if cool), except on early cultivars. See *Carbaryl (Sevin) + NAA* and *Sevin + MaxCel or Cilis Plus*, page 73.

Table 4-20. Optimum Fruitlet Size for Chemical Thinning

Cultivar	Diameter of largest fruitlets in cluster*
McIntosh	8–12 mm
Red Delicious	6.5–8 mm
Northern Spy	10–11 mm
Empire, Idared, Jonagold	8–12 mm
Gala, Golden Delicious, Fuji	8–12 mm

* Due to variability in fruit size, a sample of king fruitlets in 25-30 randomly selected clusters should be measured using a thinning template or Vernier calipers to determine the average.

For some cultivars, apply chemical thinners based on the average fruitlet diameter. See Table 4-20. *Optimum Fruitlet Size for Chemical Thinning*, on this page. Apply thinners when the king bloom fruitlets reach the stated diameter to cause the smaller and weaker fruitlets to drop off. This relationship works best when the king bloom fruitlet is larger than the side bloom fruitlets and when the size and stage of development of all fruit to be thinned is fairly uniform.

Chemical thinners are usually most effective on fruit that is 8–12 mm in diameter – but results depend significantly on weather conditions in the days following application.

For more information, see OMAFRA Factsheet, *Adjusting, Maintaining and Cleaning Airblast Sprayers*, Order No. 10-069.

Cultivar notes

Aurora Golden Gala™

Aurora Golden Gala™ can be extremely productive and therefore requires early and heavy thinning for acceptable fruit size. The cultivar appears to thin relatively well with moderate rates of carbaryl. It requires a follow-up hand thinning to space fruitlets 15–20 cm apart. Match crop load to trunk diameter. Many young Aurora trees have been cropped too heavily, resulting in small fruit, delayed maturity, poor colour, poor taste and generally poor quality fruit. This cultivar responds well to Surround Crop Protectant particle film to increase fruit size and improve shape and fruit finish.

Ambrosia

This spurry upright growing cultivar has been successfully thinned in Ontario with moderate rates of Sevin XLR. A well-thinned crop of Ambrosia finishes strongly with regard to size and colour development. The picking window for Ambrosia is narrow if the crop is to be held in long-term storage. Consult OMAFRA factsheet *Commercial Production of Ambrosia Apples in Ontario*, Order 09-041.

Cameo

Trees can normally handle heavy crop loads in a vigorous canopy. This cultivar has been shown to thin adequately with Sevin XLR (1 L/1,000 L water) on established trees.

Creston

Creston has been shown to over-thin easily with low to moderate rates of Sevin XLR. It is a productive large size cultivar that requires two pickings.

Empire

Before the application of NAA, make sure the king bloom fruitlet is set through a check of sepal posture. Petal fall of king bloom can take place as early as 3–4 days past peak pollination. If NAA is used too early (full bloom to petal fall), the overall fruit size of unthinned apples may be reduced compared to treatment at a stage when the king fruitlet is 8–10 mm in diameter.

Enterprise

Enterprise appears to thin adequately with moderate rates of Sevin XLR.

Fortune

Fortune is a large sized, highly coloured, dual-purpose apple that requires thinning to avoid biennial bearing. Fortune requires a strong treatment of NAA in combination with Sevin XLR. Experienced growers have reported success with 10 ppm NAA plus 1 L of Sevin XLR per 1,000 L of water.

Fuji

Fuji must be thinned aggressively for best results. This cultivar exhibits strong biennial characteristics and unthinned Fuji normally returns very little bloom the next year. Mature trees usually thin adequately with combinations of Sevin and NAA, but follow-up hand thinning of king fruitlets is usually necessary. Excessive crop may prevent the fruit from maturing to premium quality.

Gala

Gala is relatively difficult to thin successfully, and requires aggressive thinning on mature trees. NAA and Sevin at the rates listed for Golden Delicious have given good results, if applied when king fruitlets are 8–9 mm. Combination sprays of 6-BA and Sevin have also been very effective. Clusters must be thinned to one fruitlet or king bloom by mid to late June to achieve best fruit size. A follow-up hand thinning within 30 days of full bloom is normally required to further reduce crop load.

Late thinning sprays may increase the production of mummified fruitlets colonized by the fungus that causes black rot. Earlier applications produce fewer mummies, reducing black rot inoculum, and maturing fruit is less likely to be infected.

Gingergold

This cultivar appears to be more sensitive to thinners than McIntosh, Northern Spy and Empire. It can be over-thinned with high rates of NAA or strong combinations of NAA and Sevin XLR or MaxCel and Sevin XLR.

Golden Supreme

Unlike Golden Delicious, this cultivar will thin adequately with 1 L of Sevin XLR per 1,000 L water.

Goldrush

Goldrush requires a combination of NAA and Sevin XLR (10 ppm NAA + 1 L Sevin XLR per 1,000 L water). This cultivar is much tougher to thin adequately, but a well-thinned crop will mature more easily.

Honeycrisp

This cultivar seems to be more sensitive to thinning treatments than Empire. Thin Honeycrisp cautiously, as it can easily become oversized and is very prone to bitter pit. Where large fruit is a problem, it may be best to leave two fruitlets per cluster, or space the fruit closer together. Use of growth regulators (such as 6-BA), which enhance fruit size, may not be warranted for this large fruited cultivar. Use no more than 2.5 ppm NAA with 1 L of Sevin XLR per 1,000 L of water as a starting point on established trees. Many growers report good fruit size distribution when the largest fruitlets are removed by hand thinning following the spray thinning treatment. Honeycrisp is highly biennial in nature and may not return an adequate crop year after year.

For a discussion on crop load and trunk circumference with respect to thinning see OMAFRA Factsheet, *Commercial Production of Honeycrisp Apples in Ontario,* Order No. 05-047.

Jonagold

This cultivar thins relatively easily and has good size potential when clusters are thinned to singles. Most producers get adequate thinning with moderate rates of Sevin. Over-cropping Jonagold may result in very poor return bloom and fruit may not mature to a premium quality.

Shizuka

Shizuka thins similarly to Mutsu /Crispin with moderate rates of Sevin XLR.

Silken

Silken thins with 1–1.5 L of Sevin XLR per 1,000 L of water, depending on tree age. This cultivar bruises easily. Evenly spaced fruit in the canopy is important for ease of harvest.

Suggested rates for chemical thinning of apples

The rates in Table 4-19. *Suggested Rates for Chemical Thinning of Mature Apple Trees,* page 73, are guidelines only. There is no substitute for personal experience. It is important to keep yearly records on weather conditions, rates, etc., and above all, leave some trees unsprayed to help assess the thinning response. Use only one of the suggested chemical treatments. For example, with Wealthy, apply NAD or NAA or Sevin, or the combination. Before you alter or modify a treatment that has proven to be effective, seek the advice of a crop consultant.

Defruiting immature apple trees

In some cases, it is desirable to defruit immature apple trees to encourage proper tree development. A dilute spray of NAA at 15 ppm combined with Sevin XLR at 1.5–2 L/1,000 L of water five days after petal fall, gives acceptable results. Also, successful results have been achieved with Ethrel at a concentration between 400 and 750 mg/L (ppm) when fruit are between 10 and 30 mm in diameter, typically mid June. Well-established, supported trees under minimal stress can carry some crop load in the second year following planting.

Special conditions

Thinning after a badly frosted bloom

Carefully evaluate damage to the bloom. Petals, stamens, pistils and ovaries can exhibit a significant difference in their response to freezing temperatures. See Figure 4-4. *Anatomy of an Apple Bloom,* page 78, for further details. Although flower petals are browned off by frost, the process of fruit set can still take place from pollination that occurred 1–2 days before the frost event.

Frost around bloom usually produces a variety of frost damage symptoms:

- bands of russeting around the fruitlet called frost rings

- russeting, that runs lengthways from stem to calyx

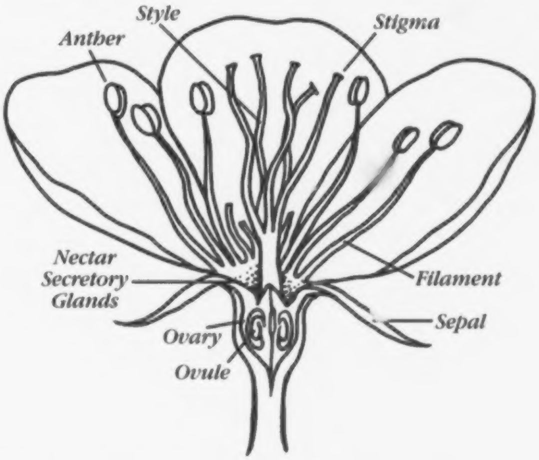
- reduced seed count and misshapen fruit (blocky or ridged)

A light amount of frost damage should not prevent the use of thinning treatments that worked in the past for any given cultivar. However, use extreme caution when thinning after a significant frost. Leaves damaged by frost absorb more of the thinner and fruitlets with reduced seed count abscise more easily. Consider the application of lower rates of thinner for many varieties under these circumstances, or on a badly damaged block, do not apply a thinner but rely on hand thinning if necessary.

Depending on the severity of the damage, growers may thin areas of the orchard that escaped the worst of the frost damage. Differences in elevation and airflow in the orchard can lead to great variations in frost damage. Trees on lower ground can be exposed to air 2–3°C colder than trees on higher ground in the same frost event.

When deciding to apply thinners, the grower may plan to spray some of the block because of what appears to be a fairly normal set on trees on higher ground. Nozzles can be shut off in areas of the block that show significant potential losses in crop load from frost. Likewise, nozzles that direct thinning sprays into the lower canopy can be shut off.

Figure 4-4. Anatomy of an Apple Bloom



Thinning when the king bloom is lost to frost

Chemical thinners usually work best when the king fruitlet is larger, stronger and more dominant than side bloom fruitlets, with the exception of Paulared. The king will normally hold on when weaker, smaller fruitlets drop in response to treatments.

If the king bloom or king fruitlet is lost to frost, size and strength differences among remaining fruitlets can be minimal, which makes them equally weak and vulnerable to thinners. The best approach in this case may be to wait until size differences appear in the cluster, provided the largest fruitlet is not greater than 12–14 mm. Size differences may become more apparent several days after full bloom. A few hours difference in pollination timing can show up in size differences of side bloom fruitlets as the postbloom period progresses.

Thinning when weather conditions are poor

Weather conditions are often not suitable for the application of thinners even though the fruitlet diameter is at the optimum size. Sometimes cold, wet, windy or rainy weather can persist for many days. It is better to wait for warmer temperatures, more sunlight and less wind, even though fruitlet diameter is increasing. Applying thinners when king fruitlets are 12–14 mm in diameter will give a better response under warmer conditions than thinners applied to king fruitlets at 8–10 mm in persistent cold, wet and rainy conditions. Wait for warmer temperatures above 18°C during the day of application or for 24 hours after spraying.

Thinning an unevenly set crop

In most cases, apply thinners even when the crop is unevenly set. Single fruitlets are much tougher to remove from the canopy. These fruitlets can be present at the same time as multiple-set clusters in the same tree or block. In comparison, fruitlets found in clusters of three to five are easier to thin because of competition within the group. Ultimately, only 5–10% of the bloom in any cultivar is required to produce a commercial crop of fruit. Therefore, in situations of uneven set on unstressed trees and in the absence of frost injury, follow the recommended thinning treatments.

Key concepts and benefits of hand thinning

For highly-valued cultivars, hand thinning immature trees is less risky than spray thinning. Hand thin promptly after June drop.

Hand thinning:

- helps to increase fruit size and manage fruit development
- helps to single the fruitlets
- balances the number of fruiting spurs with resting spurs
- enhances return bloom
- improves pest control because spray coverage is more uniform on unclustered fruit
- improves efficiency in harvest and handling of crop
- allows the tree to continue to develop canopy
- helps to prevent runted trees

Plant Growth Regulators

Promalin or Perlan to improve fruit shape of Delicious

Promalin or Perlan are plant growth regulators used on Red Delicious apples. They improve the shape of Red Delicious apples through elongation of the fruit and development of more prominent calyx lobes. They contain a mixture of benzyladenine and two types of gibberellins. For satisfactory results, time the application carefully, follow label directions and ensure complete spray coverage.

Precautions

- If Promalin or Perlan are applied at higher rates or volumes than those recommended on the label or where blooms are weak or frost-injured, fruit thinning may occur. Promalin or Perlan use may also increase the amount of thinning achieved with subsequent blossom thinning sprays.

- Apples may not respond to Promalin or Perlan if spur vigour is low or the king blossoms have been damaged by frost.
- Do not apply Promalin or Perlan if rain is expected within six hours.
- Do not apply when air temperatures are lower than 24°C or greater than 32°C.

Application notes

- For optimum results, spray the first application of Promalin or Perlan between full king bloom and early petal fall. Applications earlier or later are likely to produce unsatisfactory response.
- High relative humidity and slow drying conditions favour maximum absorption. It is preferable to apply in morning or evening.

Ethephon to enhance bloom on non-bearing trees

Apply a foliar spray of Ethrel to nonbearing apple trees, 1 to 2 weeks after bloom (determined by bearing trees in the area). On young orchard trees just beginning to initiate a few flowers, delay applications until 3 to 5 weeks after full-bloom to avoid over-thinning and misshapen fruit. Vegetative growth can be reduced during the season of application, promoting flower bud development the following spring. Trees should be large enough and at a stage to bear fruit the year following application.

For spur type trees, mix 2 L Ethrel in 1,000 L of water and apply as a dilute spray to the point of runoff. For non-spur type trees, use 4.25 L of Ethrel in 1,000 L of water. For concentrate application, apply 7 L Ethrel per hectare for spur types or 14 L Ethrel for non-spur types, in 500 L of water. Note that this rate may completely remove any fruit from trees, particularly when applied earlier than 4 weeks after full bloom.

Ethephon to promote fruit colouring

Ethephon (Ethrel) has the following effects on trees and fruit, depending upon the timing and rate of application:

- Ethrel stimulates ripening, colour development and fruit drop. To prevent excessive premature drop after the use of Ethrel, apply a suitable stop-drop product such as naphthaleneacetic acid (NAA). Two applications are required: one as a tank-mix at the time Ethrel is applied and the second five days later. Apply the stop-drop at the normal rate recommended on the label.
- Spray just the number of trees that can be harvested over a 2–3 day period. Depending on cultivar and air temperature, fruit will be ready to harvest 5–10 days after the spray is applied. After a spray, check the maturity of the apples on a daily basis for pressure, starch, flavour and colour. A few trees sprayed at 3–4 day intervals are easier to manage than a large number sprayed at one time. Make sure a market is available for the treated apples before you spray, especially with early cultivars.
- Rates of application depend on cultivar, date of application, tree vigour, temperature, weather conditions and degree of response required. Early cultivars like Jerseymac and Paulared, which ripen under warmer conditions, require less material than later cultivars. On early cultivars, use 0.75–1.5 L of Ethrel per ha with sufficient water to wet the trees thoroughly. McIntosh requires 1.5–4.25 L/ha. Use the higher rate early in the season on trees high in nitrogen or on poorly pruned trees. Use lower rates on young, well-pruned trees or on trees low in nitrogen. Best results are obtained when Ethrel is applied 2–3 weeks before harvesting. Be sure to apply Ethrel uniformly, since it works only where the spray touches.

Chemical control of preharvest drop of apples

Cultivars differ in their tendency to drop apples before harvest. McIntosh and Honeycrisp are the cultivars of the greatest concern in Ontario.

Conditions associated with premature fruit drop include:

- trees with high nitrogen content in late summer
- trees that carry a heavy crop
- hot days and warm nights just before and during harvest
- trees deficient in either moisture or the nutrients boron or magnesium
- trees heavily damaged by pests

Products to control preharvest drop

NAA

Products such as Fruitone-N and Fruit Fix Concentrate contain NAA (naphthaleneacetic acid) and are registered to control drop on apples. These contain the same active ingredient, NAA, used at different concentrations than for thinning.

- Apply NAA as soon as the first undamaged apples begin to drop, at the rate of 10 ppm or single strength rate. Timing is important. Do not confuse the normal preharvest drop of sound apples with those that have been pushed off or are dropping because of insects, disease or nutritional deficiency.

- NAA is effective for 7–10 days after it is sprayed. For stop-drop prevention beyond this, repeat the application of a single strength rate every 7 days. It takes 1–2 days for NAA to take effect if applied before any harvest has taken place. If applied after the orchard has been spot picked, it may take longer to take effect. Therefore, apply NAA as soon as the spot pick is finished. Do not apply NAA closer than 5 days before harvest. Refer to the label.

- Apply NAA in a dilute spray to achieve more uniform coverage. This is important because NAA is only locally systemic. High volumes of water take longer to dry and allow increased absorption of NAA. The optimum conditions for maximum absorption are at or near 21–24°C and high humidity. Absorption is less on foliage injured by insects, diseases or frost and at temperatures below 16°C.

- The addition of a non-ionic type spreader sticker like Agral 90 improves absorption of NAA under less than ideal weather conditions.

- NAA inhibits fruit abscission but the fruit continues to mature at an accelerated rate. The higher the concentration used and the greater the number of applications, the greater the ripening effect. One application of single strength (10 ppm) has little effect on direct ripening.

- Apples treated with NAA for preharvest drop will not keep well in long term storage, especially McIntosh. Apples treated twice with NAA should be sold immediately.

ReTain

ReTain is a plant growth regulator and an effective preharvest drop control agent for apples, such as Gala, Honeycrisp, McIntosh, Red Delicious and Northern Spy. It reduces the production of ethylene in maturing apples.

- Apply this material 4 weeks before anticipated harvest date. ReTain may delay maturity of apples on the tree and allow a longer harvest window for a particular variety. Although ripening in ReTain-treated fruit is temporarily delayed, ReTain-treated fruit harvested at proper maturity may have increased soluble solids, colour, fruit size, fruit firmness and reduced water core.

- Pick fruit treated with ReTain at the same internal maturity, based on starch-iodine tests, as untreated fruit. There may be a 7–10 day delay from predicted harvest date of untreated fruit to the start of the harvest of ReTain-treated fruit.

Recommended use 4 weeks before anticipated harvest

- Use one 333 g pouch (50 g active ingredient) of ReTain per 0.4 ha (1 acre). Use with Sylgard 309 (organosilicone surfactant) at 0.5–1 L of Sylgard 309 per 1,000 L of water.

- Apply 4 weeks before anticipated harvest, adjusted for seasonal differences that have advanced or delayed "normal" harvest date. It is better to be a week early than a week late. Late applications will not perform well because ethylene production within the plant may have already begun and this is difficult to suppress once initiated. To help determine the start of the "normal" harvest period, refer to historical trends for harvest dates for each cultivar in your area.

Precautions

- When you mix ReTain with the surfactant, keep agitation to a minimum because Sylgard 309 has a tendency to foam.

- To minimize foam, add Sylgard 309 last, when the tank is full. Compatibility and performance data for ReTain with antifoam products are not available.

- Do not use surfactants other than Sylgard 309 because they are not registered with ReTain in Canada. If the rate of ReTain is reduced, maintain the Sylgard rate at a 0.05%–0.1% v/v ratio.

- Discard any unused spray material at the end of each day.

- Do not tank-mix with other products except Dipel or Foray. Combination effects and potential interactions between ReTain and NAA (napthaleneacetic acid) or ethephon products have not been thoroughly evaluated. Use of these products on ReTain-treated blocks may negate or reduce the benefits of ReTain.

- Do not use overhead irrigation for 8 hours after application.
- Adjust spray water volumes based on tree size and spacing. Do not apply to the point of runoff but wet the tree under slow drying conditions. Use tree-row volume (TRV) reductions cautiously and test on a few rows or small blocks to gain a level of comfort with this technique. For many orchards, 1,000 L water per ha is adequate for size-controlling rootstocks.
- For best results, have spray water at a pH between 6 and 8.

To maximize the benefits of using ReTain, segregate treated fruit from untreated fruit in storage to reduce exposure to ethylene.

Additional considerations when using ReTain

- Spray only trees that are healthy and not under severe drought, insect, disease or nutritional stress.
- Apply treatments to Gala strains, Golden Delicious types and Honeycrisp with caution. These cultivars appear to be more responsive to ReTain compared to McIntosh. Using ReTain on these sensitive cultivars can significantly impede crop maturity and development.
- For multiple-pick cultivars such as Royal Gala, time application four weeks from the second harvest pick date for best results.
- The harvest window for treated cultivars is shorter but delayed and results in fewer pickings. This can increase harvest efficiency.
- ReTain is not likely to compensate for the effects of an aggressive calcium spray program to control bitter pit. Calcium sprays can advance apple maturity by accelerating ethylene production in maturing fruit.

Vegetative growth control in apples

Apogee or prohexadione-calcium, is a plant growth regulator that reduces terminal shoot growth. Apogee inhibits the synthesis of gibberellins, the plant hormones responsible for cell elongation. Trees treated with Apogee often have the same number of shoots as untreated trees, but shoots from treated trees are thicker or greater in diameter and have compressed internodes.

When used properly in apple orchards, Apogee can:

- reduce shoot growth by 20–60% and diminish the time required to dormant prune and/or summer prune
- lead to improved fruit colour on red-coloured cultivars
- result in a more open tree canopy, which will improve spray coverage
- reduce the incidence and severity of fire blight on shoots, but not blossom blight infections

Apogee does not have activity against the fire blight bacteria. Trees with reduced shoot growth make the trees less susceptible to fire blight development. Apogee does not reduce the number of leaves or fruit size.

Time of application and rates

Patterns of terminal growth and fruit set differ among growing regions. Likewise, the response to Apogee appears to differ between regions. Therefore, the rate and calendar date of application may vary between regions.

Make the first application when terminal shoots (and/or bourse shoots) are no longer than 2.5–5 cm. Some cultivars show early bourse shoot development (see Figure 4-5. *Diagram Indicating Bourse Shoot Development*, page 82). **Note: This first application timing may occur during bloom or petal fall.** Sufficient leaf area must be available for Apogee to be translocated into the leaf. Later timings will not provide satisfactory results.

Apogee is non-toxic to bees, so the first application can be made before bees are removed from the orchard.

Once applied, Apogee requires about 14 days to slow growth. It breaks down in the trees within a few weeks, so at least one additional application may be necessary to maintain growth control throughout the entire growing season.

See Table 4-21. *Suggested Apogee Rates and Timings Based on a Tree-row Volume Dilute of 1,000 L/ha*, page 82, for rates. The application rate is determined primarily by tree size, vigour, and whether protection against shoot blight is an objective.

- for medium to high vigour trees apply 45 g product per 100 L of dilute spray (125 ppm)
- for low to medium vigour trees apply 27 g product per 100 L of dilute spray (75 ppm)

Table 4-21. Suggested Apogee Rates and Timings Based on a Tree-Row Volume Dilute of 1,000 L/ha (use this chart in conjunction with the product label)

Apogee Program Level		1st Spray	2nd Spray	3rd Spray	4th Spray	Season total[4] (g/ha)
	Stage →	**Petal Fall**	**Fruit Set**	**June Drop**	**Growth**	
	Typical Date[1], SW Ontario →	**25-May**	**8-Jun**	**22-Jun**	**6-Jul**	
	Tree vigor[2]	**(g Apogee per ha based on 1,000 L/ha TRV (tree-row volume) dilute)[3]**				
1	Low – 1 spray	450				450
2	Low – 2 sprays	270	270	—	—	540
3	Medium – 2 sprays†	450	450	—	—	900
4	Medium/High – 3 Sprays	450	450	270	—	1170
5	High – 3 sprays	450	450	450	—	1350
6	High – 4 sprays	450	450	450	270	1620

† - Suggested base rate. Move to next higher or lower level based on factors listed below.

Orchard and Environmental Factors to Adjust Apogee Rates and Number of Sprays		
	Heavy dormant pruning	increase rate by 10–20 % per ha per spray
	Longer growing season	add 3rd or 4th spray
	Low crop load	move Apogee Program to next higher level
	Questionable coverage	move Apogee Program to next higher level
	Fire blight suppression	move Apogee Program to next higher level or apply (650 g/1,000 L) initial rate

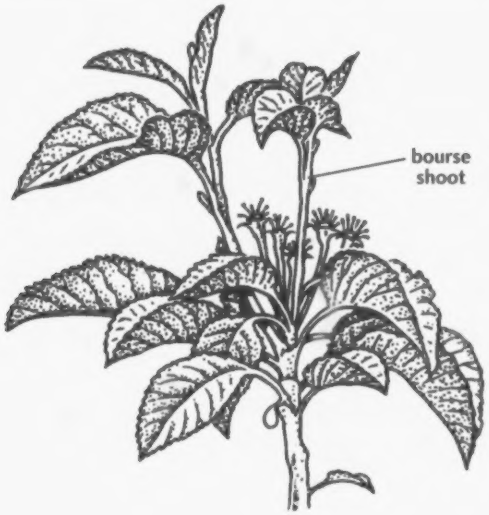
[1] Make the first application when terminal shoots are no longer than 2.5–5 cm, which usually corresponds with late bloom to petal fall. This will vary with tree growth and development in your area and by cultivar. These are approximate dates in southwestern Ontario. Growers with orchards in other areas should note the appropriate tree phenology stage to time these applications correctly.

[2] Vigour is defined as the total amount of shoot growth in a single season, not to be confused with tree-row volume.

[3] Tree-row volume (see OMAFRA Factsheet, *Adjusting, Maintaining, and Calibrating Airblast Sprayers*, order no. 10-069, for more details). Rates need to be increased when higher water volumes are required for adequate spray coverage.

[4] Maximum seasonal rate should not exceed a total of 5.4 kg of Apogee.

Figure 4-5. Diagram Indicating Bourse Shoot Development



Repeat application(s) should be made at 14–21 day intervals, based on the level of growth control required.

Follow the steps on the label to adjust rates for tree-row volume dilute applications. Table 4-21. *Suggested Apogee Rates and Timings Based on a Tree-Row Volume Dilute of 1,000 L/ha,* on this page, shows various rates for sprays applied at 1,000 L/ha (dilute). Apogee has been used effectively when applied in more concentrated sprays provided thorough wetting of the canopy is achieved. Low-volume spraying of plant growth regulators and chemical thinners is not recommended.

Do not tank mix Apogee with calcium sprays like calcium chloride. In the presence of calcium, Apogee will precipitate in the tank, clog nozzles and screens, and reduce tree response.

Adjuvants and hard water

Include the spray adjuvant, Agral 90, with Apogee to improve the uptake of the prohexadione-calcium molecule by the leaf. In addition, if the spray water source is hard water and contains high levels of calcium or magnesium, include an equal amount of ammonium sulphate (AMS) fertilizer by weight with Apogee. Use a high-quality, greenhouse grade of AMS to avoid plugging of nozzles. Obtain water hardness ratings from your municipal water supplier, or have well water tested for hardness. Consult *www.ene.gov.on.ca/en/water/sdwa/licensedlabs.php* for a list of accredited labs that conduct these tests.

Precautions when using Apogee

In some instances, Apogee may increase fruit set and make thinning more difficult. This response is not consistent but is more likely at concentrations above 125 ppm (45 g/100 L). Apogee-treated trees may require more aggressive chemical or hand thinning to reduce the crop load to the desired level.

Apogee can cause severe cracking on Empire and Stayman cultivars as stated on the product label. The cause is unclear, but may be related to environmental conditions. Reports of cracking damage of Empire when Apogee has been used are increasing. Compliance with the label is strongly advised. Apogee may result in decreased yield and marketable yield of Cortland. Despite this, clear benefits of the use of Apogee on tip bearing cultivars such as Cortland and Northern Spy have been observed in other regions of Canada where the shortened internodes of Apogee treated trees has produced a more compact tree habit.

5. Berry Crops

Berry Crop Nutrition

Blueberries, Highbush

Blueberries perform best on acidic, well-drained soils with high organic matter content.

- Before you plant, test the soil to determine the pH and fertilizer requirements.
- Incorporate acidic peat moss with the soil in the planting hole to significantly improve plant establishment and development. Dry peat moss will draw soil moisture away from plant roots so be sure it is thoroughly moistened before planting.

pH requirements

Blueberries require a soil pH between 4.2 and 5.0 for optimum growth and production. A soil pH above 6.5 usually cannot be lowered economically through the use of sulphur or peat moss. For this reason, choose the site for blueberry production carefully.

- If the soil pH is too high but less than 6.5, acidify through the incorporation of elemental sulphur and/or acidic peat moss prior to planting. See Table 5-1. *Amount of Sulphur Required to Lower Soil pH,* on this page.
- Incorporate sulphur at least one year prior to planting to allow sufficient time for the sulphur to acidify the soil.
- Check the soil pH annually in the plant row and add sulphur when necessary.

Fertilizer for blueberries

Nitrogen (N)

Highbush blueberries respond best to ammonium forms of nitrogen. Use ammonium sulphate (21% N) if the soil pH is above 5.0 and urea (46% N) if the pH is below 5.0. Avoid using the nitrate form of nitrogen. Avoid fertilizers containing lime filler as they will raise the pH of the soil. In the spring after planting, apply a total of 12 g of actual nitrogen per bush in a split application. Increase the rate of nitrogen each year until a total of 36–48 g per bush is applied. Apply the nitrogen just prior to bud break, petal fall and early July. Distribute the fertilizer in a circle from 30 cm around the plant to just beyond the spread of the branches. On older bushes, apply most of the fertilizer under the outer spread of the branches. See Table 5-2. *Nitrogen Requirements for Highbush Blueberries,* on this page.

Table 5-1. Amount of Sulphur Required to Lower Soil pH (kg/ha)

Soil type	For each 1.0 pH unit	For each 0.1 pH unit
sand	350	35
sandy loam	750	75
loam	1,100	110

Example: The initial pH of a sandy loam soil is 6.2; the desired soil pH for blueberries is 4.8. The soil pH must be lowered by 6.2–4.8 = 1.4 units. Therefore, 1.4 x 750 = 1,050 kg/ha of sulphur is required.

Table 5-2. Nitrogen Requirements for Highbush Blueberries

	April 1–15	May 15	July 1
Plant Age	(g N per plant)		
Newly planted	0	6	6
1 year	3	6	6
2 year	6	6–12	6–12
3 year	9	6–12	6–12
4 year	12	12–18	6–12
5 year	15	12–18	6–12
6 year or older	18	12–18	6–12

Phosphorus (P) and Potassium (K)

Apply phosphorus and potassium according to soil tests. Consult Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries,* page 86, for soil test interpretation. A single application of phosphorus at soil preparation time is usually all that is required. It is critical to correct phosphorus deficiencies prior to planting.

Apply all of the required potassium early in the spring under the outer branches of the bushes, as described for nitrogen. Potassium can be mixed and applied with the spring nitrogen. Use sulphate of potash magnesia (22% potash, 11% magnesium) or potassium sulphate (50% potash). Blueberries are sensitive to injury from the chloride contained in muriate of potash (0-0-60).

Table 5-3. Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries

Phosphorus				Potassium		
Soil test (ppm P)*	Rating	Phosphate required (kg P_2O_5 per ha)		Soil test (ppm K)**	Rating	Potash required (kg K_2O per ha)
		New plantings	Established plantings			
0–3	HR	140	100	0–15	HR	130
4–5		130	90	16–30		120
6–7		120	80	31–45		110
8–9		110	70	46–60		100
10–12		100	70	61–80		90
13–15		90	60	81–100		80
16–20	MR	70	50	101–120	MR	70
21–25		60	40	121–150		60
26–30		50	30	151–180		40
31–40		40	20			
Above 40	LR	0	0	Above 180	LR	0

* 0.5 M sodium bicarbonate extract.

** 1.0 N ammonium acetate.

HR, MR, LR, denote, respectively: high, medium, and low probabilities of profitable crop response to applied nutrient.

Other nutrient requirements

Magnesium (Mg) deficiency may occur on blueberries. Soil and/or foliar applications of magnesium are required to correct this deficiency. For soil applications, 80 kg Mg per ha is required where a confirmed deficiency exists. Use magnesium sulphate (Epsom salts, 9.5% Mg) or sulphate of potash magnesia (21% potash, 11% Mg). Since sulphate of potash magnesia contains potash, adjust the rate of application to coincide with potash requirements. For foliar sprays, 1.9 kg Mg per 1,000 L of water (20 kg magnesium sulphate, Epsom salts) with at least 2,000 L/ha should correct the deficiency. Annual foliar sprays may be necessary.

Table 5-4. Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves

Element	Acceptable Range
Nitrogen (N)	1.7–2.3%
Phosphorus (P)	0.15–0.4%
Potassium (K)	0.36–0.7%
Calcium (Ca)	0.3–0.8%
Magnesium (Mg)	0.12–0.3%
Manganese (Mn)	150–500 ppm
Iron (Fe)	30–100 ppm
Zinc (Zn)	10–100 ppm
Boron (B)	15–50 ppm

See Appendix C. *Accredited Soil-Testing Laboratories in Ontario*, page 289, for a list of laboratories that provide leaf analysis.

Leaf analysis

Leaf tissue analysis can help to assess the nutrient status of the plants and more accurately determine fertilizer requirements. In late July, take leaf samples from halfway down the new shoot growth of the current season. For adequate representation, collect at least 100 leaves throughout the sampling area. Separately sample areas with different soil, plant vigour, fertility programs, etc. See Table 5-4. *Standard Ranges for Nutrient Levels in Highbush Blueberry Leaves*, on this page.

Currants and Gooseberries

It is essential to apply and incorporate required materials such as phosphorus, potassium, organic matter and lime before you plant currants and gooseberries because these materials do not move through the soil easily.

Prepare the soil and adjust pH as required, as determined by a soil test at least a year before planting. This will ensure the plants can maintain productivity and grow successfully in the same location for many years.

Currants and gooseberries grow best in cool, well-drained, deep, loamy soils. The soil organic matter should be at least 2–3% to promote good drainage, aeration and moisture retention.

Apply 45 tonnes/ha or 4.5 kg/m^2 of well-composted manure in late summer or fall before planting. Other organic materials such as weed-free straw may be used, but these materials should be well decomposed by planting time. For more information on organic matter, see Soil Management at *www.ontario.ca/crops*.

pH requirements

An acceptable soil pH for currants and gooseberries is between 5.5 and 7.0. A slightly acid soil (pH 6.1–6.6) is best. Liming of soil may be required to raise soil pH to 6.1.

If lime is needed, apply at least 6–12 months before planting. For more information on lime, consult *Soil pH and Liming*, page 18. Micronutrients may become limiting if soil pH is outside the recommended range.

Fertilizer before planting

Incorporate phosphorus and potassium fertilizer into the soil in early spring a few days before planting. Incorporate nitrogen before planting or apply in a band around the bush several weeks after planting. Apply fertilizer at least 30 cm away from the base of the bush to avoid burning roots with the nitrogen. If planting takes place in the fall, incorporate required phosphorus before planting but delay application of nitrogen and potassium until the following spring.

Nitrogen (N)

Incorporate or band 5 g of actual nitrogen per bush in the planting year.

Phosphorus (P)

Test the soil before planting and incorporate the required amount of phosphorus according to the soil test results. See Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, page 86, for more information. Recommended phosphorus rates to meet plant requirements must be incorporated prior to planting. Phosphorus does not move easily through the soil to the roots. It is difficult to effectively incorporate phosphorus after the crop is planted. Excessive levels of phosphorus can induce deficiencies of other essential nutrients such as zinc.

Potassium (K)

Test the soil before planting and apply the required amount of potassium according to the soil test results. See Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, page 86. Currants and gooseberries are sensitive to injury from the chloride contained in muriate of potash (0-0-60). Use sulphate of potash or sulphate of potash magnesia instead.

Fertilizer in established plantings

Apply fertilizer early each spring according to soil tests. If phosphorus and potassium are not broadcast over the entire area, reduce rates to the percentage of area that will receive fertilizer. If the fertilizer is banded, band 30 cm from the base of the plant.

Nitrogen (N)

Apply 10 g nitrogen per bush in the year after planting. In subsequent years, apply 20 g per bush.

Potassium (K)

Apply according to soil test results. If a soil test is not available, assume a moderate level and apply as indicated in Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries*, page 86.

Raspberries

Raspberries have a fine, fibrous root system and perform best on a deep, well-drained soil. Raspberry soils need good water retention ability and a high organic matter content of approximately 3%. For more information on organic matter, see Soil Management at *www.ontario.ca/crops*.

One year before planting raspberries, test the field soil for phosphorus, potassium, magnesium and pH. Adjust soil pH and organic matter if necessary. Plant a weed-smothering cover crop and incorporate it into the soil to build up organic matter. Apply well-composted manure (45 tonnes of cattle manure per ha) and incorporate into the soil the year before planting.

pH requirements

Raspberries grow best at a soil pH of 5.5–6.5, although they can grow well in soils with a higher pH. Liming of soil may be required to raise soil pH to 6.1. If lime is needed, apply at least 12 months before planting. For more information on lime, consult *Soil pH and Liming*, page 18. Micronutrients may become limiting when soil pH falls outside the recommended range.

Fertilizer for raspberries

Nitrogen (N)

Recommended nitrogen rates are found in Table 5-5. *Recommended Nitrogen Rates for Raspberries,* on this page. Avoid the application of excessive nitrogen. It can reduce the number of berries per cane and cause excessive vegetative growth. Sources of nitrogen and nitrogen equivalents are presented in Table 3-10. *Fertilizer Materials: Primary Nutrients,* page 21.

For summer and fall-bearing raspberries, apply nitrogen in early spring (late March to early April). Late applications may lead to winter injury. For fall bearing raspberries, winter injury is not a concern because canes are removed each spring. However, ripening may be delayed where nitrogen is applied in excess.

Table 5-5. Recommended Nitrogen Rates for Raspberries

	kg N per ha per season
Planting year	30–40
Second year	40–60
Third and following years	45–75

Use the lower rates on non-irrigated crops and heavier soils. Apply higher rates to irrigated crops and sandier soils.

Phosphorus (P) and Potassium (K)

Use a soil test to determine the need for phosphorus and potassium before planting. Apply the required amount of phosphorus and potassium according to the soil test.

Incorporate phosphorus prior to planting to correct phosphorus deficiencies, as phosphorus does not move readily through the soil. Do not apply more phosphorus than is required; excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc.

If the soil test recommends high rates of potash, use sulphate of potash (0-0-50) or sulphate of potash magnesia (0-0-22). Raspberries are sensitive to chlorides. Some root injury has been observed on sandy soils where muriate of potash (potassium chloride, 0-0-60) has been used at a high rate. For sources of phosphorus and potash, refer to Table 3-10. *Fertilizer Materials: Primary Nutrients,* page 21.

Once plants are established, take soil samples from where plants are rooted, rather than from between the rows. Sample the soil every two to three years.

Leaf analysis

Collect fully expanded mature raspberry leaves from fruiting canes in late July. See Table 5-6. *Ranges for Nutrient Levels in Raspberry Leaves,* on this page. These ranges provide a guide for interpretation of results. Variation can occur because of cultivars, soil type and cultural practices.

Table 5-6. Ranges for Nutrient Levels in Raspberry Leaves

Element	Range
nitrogen (N)	2–3.5%
phosphorus (P)	0.2–0.5%
potassium (K)	1–2%
calcium (Ca)	0.8–2.5%
magnesium (Mg)	0.25–0.5%
manganese (Mn)	20–200 ppm
iron (Fe)	25–200 ppm
zinc (Zn)	15–100 ppm
copper (Cu)	5–20 ppm
boron (B)	20–60 ppm

See Appendix C. *Accredited Soil-Testing Laboratories in Ontario,* page 289, for a list of laboratories that provide leaf analysis.

Strawberries

Strawberries are shallow-rooted, perennial plants. Heavy demands are placed on the root system, especially in the short period when berries develop. Strawberries require well-drained soils with 2% or higher organic matter and high fertility. Provide an optimum environment for strawberry root growth to obtain a profitable, perennial planting.

One year before planting strawberries, adjust soil pH and organic matter. Plant a weed-smothering cover crop and incorporate it into the soil to build up organic matter. Apply well-composted manure (45 tonnes of cattle manure per ha) and incorporate into the soil the year before planting. Test the field soil for phosphorus, potassium, magnesium and pH.

pH requirements

The optimum soil pH for strawberry production is 6.0–6.5. Strawberries will grow at a wider range of soil pH, however some micronutrients become less available outside this range, particularly when soil pH is above 7.0. A soil pH below 5.6 on clay loam and below 6.1 on sandy loam should be adjusted upwards by applying lime the year before planting. For more information on pH, consult *Soil pH and Liming,* page 18.

Fertilizer for new plantings (the planting year)

Phosphorus (P)

Use soil test results to determine the best rate of phosphorus to apply. Table 5-3. *Phosphorus and Potassium Requirements for Highbush Blueberries, Strawberries, Raspberries, Currants, Gooseberries,* page 86, shows soil test values and fertilizer requirements for new strawberry plantings. Incorporate phosphorus into the soil before you plant. Soils differ in the amount of phosphorus available to plants. Generally, fields cultivated for a long time require less phosphorus than recently developed fields.

Starter Solutions:

To help the plant establish, particularly if the soil is cold, use a starter fertilizer solution. Plant uptake of soil phosphorus can be reduced when soils are cold. Use a starter solution high in phosphorus such as 10-52-10, 6-24-6 or 10-24-0. Follow the manufacturer's suggested application rate.

Potassium (K)

Use soil test results to determine the best rate of potassium to apply. Incorporate potassium into soil before planting. Side dressing of potassium is not generally recommended.

Nitrogen (N)

Nitrogen can be applied with the phosphorus and potassium or as a side dressing two to three weeks after planting. Apply 50 kg of N per ha. See Table 3-10. *Fertilizer Materials: Primary Nutrients,* page 21, for nitrogen content of fertilizers. Apply an additional 25–35 kg N per ha in mid-August to further invigorate plants as they initiate fruit buds for the next year's crop.

Use whatever form of nitrogen is economical. Brush pelleted forms, such as ammonium nitrate, off the leaves to prevent burning. Do not apply when leaves are wet. The nitrogen in urea (46-0-0) can be lost as ammonia gas if it is applied to the soil surface. This ammonia can cause strawberry leaves to blacken. Incorporation of urea prevents this problem.

Strawberries require annual applications of nitrogen. The timing of nitrogen application is as important as the rate of nitrogen. Improper timing and/or rates of nitrogen may lead to an increase in winter injury, softer fruit, and higher incidence of disease.

Adjust nitrogen rates proportionately if manure was applied. See Table 3-11. *Average Fertilizer Replacement Values For Different Types Of Manure,* page 22. For more information about food safety and the environmental effect of manure application, please see *Use manure responsibly,* page 22, and *Manure and food safety,* page 23.

Fertilizer for established plantings

Nitrogen (N)

Do not apply nitrogen in the spring, particularly on vigorous varieties. Spring applications cause extra vegetative growth and vigour, which results in softer fruit and dense canopies. This increases the potential for botrytis fruit rot. Although spring-applied nitrogen may increase berry size, it also delays maturity by one or two days.

Benefits have been reported from the application of low rates of nitrogen (10–20 kg N per ha) to coarse-textured soils in the spring after mulch removal. Established fields on sandy soils or fields suspected of having winter injury might benefit from light spring applications of nitrogen. Experiment with spring-applied nitrogen on a small scale.

The best time to apply nitrogen in established fields is at renovation. After you mow the foliage, apply 50 kg N per ha using whatever form of nitrogen is most economical. See Table 5-7. *Recommended Nitrogen (N) Rates for Strawberries,* page 90. Brush pelleted forms such as ammonium nitrate off the leaves to prevent burning. Do not apply nitrogen when leaves are wet. The nitrogen in urea (46-0-0) can be lost as ammonia gas if it is applied to the soil surface. This ammonia can cause strawberry leaves to blacken. Incorporation of urea prevents this problem. Apply an additional 25–35 kg N per ha in mid-August to assist the development of next year's fruit buds.

Ensure soils are well irrigated after renovation, throughout the summer and in early fall. Adequate soil moisture is needed to optimize nitrogen uptake.

Phosphorus (P)

If a soil test shows phosphorus is needed, apply at renovation with nitrogen and potassium. Excessive phosphorus levels may cause zinc deficiency, especially on sandy soils.

Potassium (K)

Apply potassium, as determined by a soil test, with nitrogen and phosphorus at renovation. This allows incorporation. Use soil tests to determine what rate to apply and use leaf analysis to adjust rates. Excessive levels of potassium induce magnesium deficiency, particularly on sandy soils.

Table 5-7. Recommended Nitrogen (N) Rates for Strawberries

	Before planting or 2–3 weeks after planting	Renovation (after harvest)	Mid-August
Planting years	50 kg N per ha		25–30 kg N per ha
Established plantings		50 kg N per ha	25–30 kg N per ha

Leaf analysis

Leaf analysis can help assess the nutrient status of strawberry plants and more accurately determine fertilizer requirements. Take leaf samples by July 1 for fruiting or August 20 for non-fruiting plantings. Collect at least 50 fully expanded, recently matured leaves with petioles removed. Sample different varieties and plantings separately. See Table 5-8. *Optimum Nutrient Level Range of Strawberry Leaves,* on this page, for interpretation of leaf analysis values.

Table 5-8. Optimum Nutrient Level Range of Strawberry Leaves*

Nutrient	Optimum Range
nitrogen (N)	2%–3%
phosphorus (P)	0.2%–0.5%
potassium (K)	1.5%–2.5%
calcium (Ca)	0.5%–1.5%
magnesium (Mg)	0.25%–0.5%
manganese (Mn)	20–200 ppm
iron (Fe)	25–200 ppm
zinc (Zn)	15–100 ppm
boron (B)	20–60 ppm

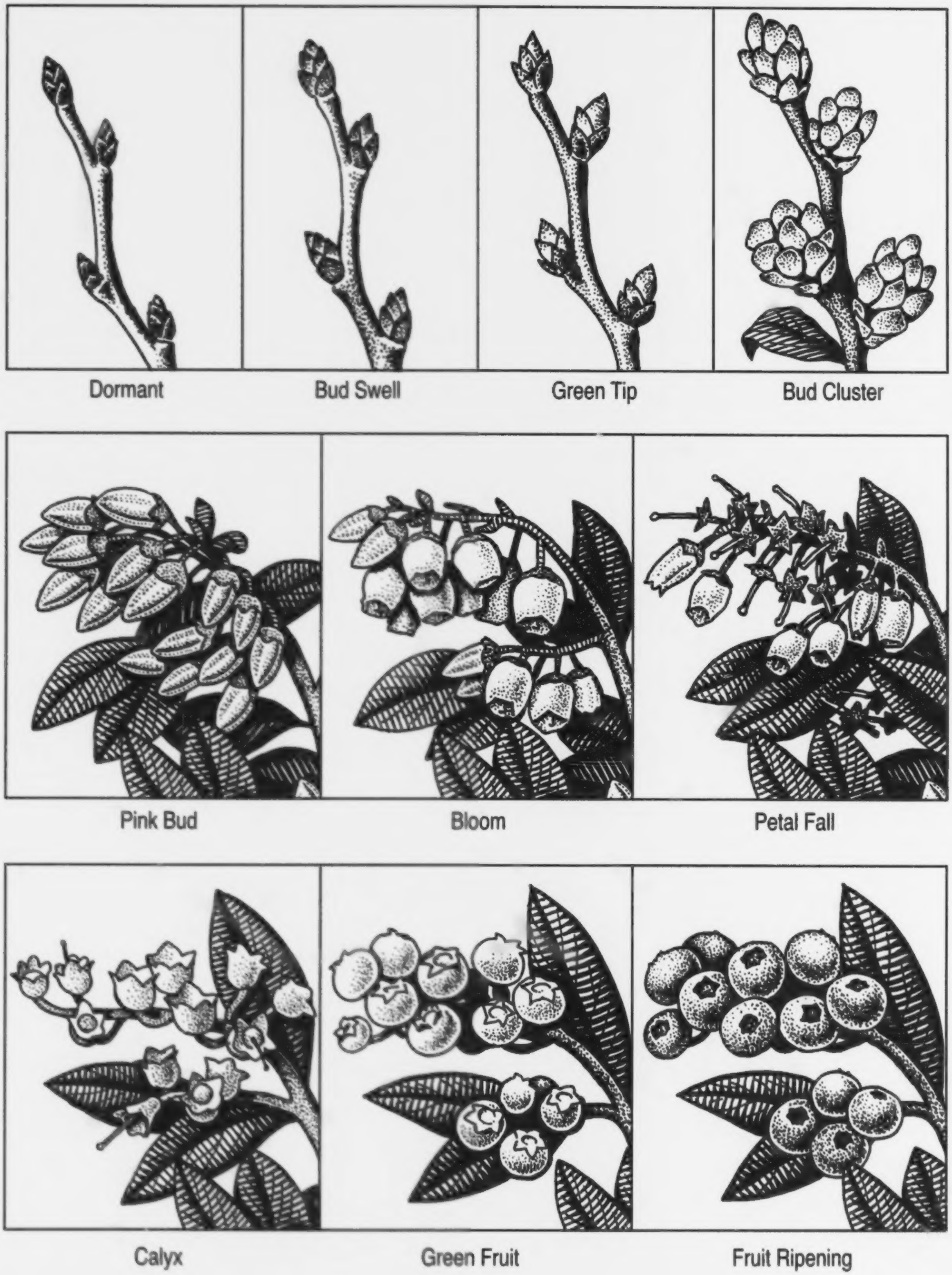
* Fully expanded, recently matured strawberry leaves with petioles removed, collected before July 1 in fruiting fields and before August 20 in non-fruiting fields.

See Appendix C. *Accredited Soil-Testing Laboratories in Ontario,* page 289, for laboratories that provide leaf analysis.

Micronutrients for Berry Crops

Deficiencies of micronutrients are not widespread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Apply only the deficient nutrient in sufficient quantities to correct the problem. Leaf analysis is more effective than soil analysis to evaluate a crop's micronutrient status. See *Micronutrients,* page 26, for additional information.

Figure 5-1. Blueberry Growth Stages



Dormant

Bud Swell

Green Tip

Bud Cluster

Pink Bud

Bloom

Petal Fall

Calyx

Green Fruit

Fruit Ripening

Blueberry Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. For mature highbush blueberries, use 700–1,000 L of water per ha unless otherwise noted on the label.

Products are listed according to insecticide and fungicide family groups. Use products from different groups to prevent the development of pest resistance. For resistance management, refer to *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 5-9. *Products Used on Blueberries,* page 97.

Diseases and Insects	Products	Rate	Comments
Dormant (late winter)			
Scale insects Lecanium scale	• Lime Sulphur plus Dormant Oil Spray • Purespray Green Spray Oil 13E	36.7 L Lime Sulphur plus 12.5 L Oil/1,000 L water 20 L /1,000 L water	Apply when plants are dormant. Spray to the point of runoff. Ensure thorough spray coverage. Use 1,000–1,500 L of water per ha. Do not use within 10 days of Bravo, Echo, Captan, Maestro, or phytotoxicity may result. Do not use within 48 hours of freezing temperatures. **Purespray Green Spray Oil:** Labelled for Lecanium scale only.
Early spring, prior to bud break			
Phytophthora root rot	• Ridomil Gold 480 SL	Banded: 37 mL/100 m of row	If phytophthora root rot has been identified, apply 37 mL/100 m of row to the soil surface in a 1 m band centered over the row. Apply in at least 2,000 L of water per ha. Alternatively, use Aliette at **Bud swell to pink bud**. Improve soil water drainage and adjust irrigation schedules to reduce problems with this disease.
Bud swell to pink bud			
Leaf tiers	• Decis 5 EC	150 mL/ha	Damage from this occasional pest occurs very early in the season. If leaf tier was a problem in the past, spray at the bud cluster stage as flower buds begin to swell and pink tissue becomes visible.
Obliquebanded leafroller (OBLR)	• Delegate WG • Success 480 SC or Entrust 80 W	200 g/ha 145–182 mL/ha 80–109 g/ha	Where OBLR has been a problem in the past, spray if overwintering OBLR larvae are easy to find. Otherwise, use pheromone traps to monitor for adults and spray for the summer generation at **Green fruit**. Many of these products are also labelled for spanworms (known as inchworms or loopers) and other caterpillars. See product label for a complete list of registered uses.
Mummy berry *(Monilinia)*	• Funginex DC • Topas or Jade or Mission 418 EC • Allegro 500 F • Serenade ASO	1.7–3 L/ha 500 mL/ha 500 mL/ha 300 mL/ha 2.24 L/ha 24 L/ha	Cultivate before bud break to bury overwintering inoculum. Monitor for trumpet-shaped structures erupting from mummified berries on the ground. Protection is needed when these structures are present. Spray to prevent primary infection of blueberry shoots. Make the first application when the flower buds swell and repeat to ensure protection until first bloom. **Funginex:** Do not spray after pink bud stage. **Topas, Mission, Jade:** Use a maximum of two applications per season. **Allegro, Serenade ASO:** These products provide suppression rather than control of mummy berry . See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13. **Serenade ASO:** See notes on *Bacillus subtilis (Serenade ASO, Serenade MAX),* page 242. Expect best results from multiple applications or when used in rotation with other products.
Phytophthora root rot	• Aliette WDG	5.6 kg/ha	If phytophthora root rot has been identified, apply in spring when there is 7 cm of new growth and repeat in 14–21 days. Improve soil water drainage and adjust irrigation schedules to reduce problems with this disease.

Diseases and Insects	Products	Rate	Comments
Green tip			
Anthracnose fruit rot Phomopsis	• Cabrio EG • Pristine WG • Bravo 500 or Echo 720 • Allegro 500 F • Aliette WDG	1 kg/ha 1.3–1.6 kg/ha 7.2 L/ha 5 L/ha 2.24 L/ha 5.6 kg/ha	Apply fungicides to prevent twig blights and reduce overwintering inoculum. **Pristine:** Use 1.6 kg/ha for phomopsis stem canker. **Pristine, Cabrio:** These products include active ingredients in the same fungicide group. Use a maximum of two consecutive applications, then alternate with fungicides from different groups. **Bravo, Echo:** Will also control alternaria fruit rot. **Allegro:** Provides suppression rather than control of both phomopsis and anthracnose. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. **Aliette:** Apply at 14–21 day intervals. Provides suppression rather than control of phomopsis. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13.
Pink bud			
Anthracnose fruit rot Phomopsis	Use one of the fungicides listed at **Green tip.**		
DO NOT APPLY INSECTICIDES WHILE BLUEBERRIES ARE IN BLOOM. SEE *BEE POISONING* ON PAGE 267.			
First bloom			
Anthracnose fruit rot Phomopsis	• Cabrio EG • Pristine WG • Switch 62.5 WG • Allegro 500 F • Aliette WDG	1 kg/ha 1.3–1.6 kg/ha 775 g /ha 2.24 L/ha 5.6 kg/ha	**Pristine, Cabrio:** These products include active ingredients in the same fungicide group. Use a maximum of two consecutive applications then alternate with fungicides from different groups. **Pristine:** Use 1.6 kg/ha for phomopsis stem canker. **Allegro:** Provides suppression rather than control of both phomopsis and anthracnose. **Aliette:** Apply at 14–21 day intervals. Provides suppression rather than control of phomopsis. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. **Switch:** Use for anthracnose fruit rot, not labelled for phomopsis.
Botrytis twig and blossom blight Botrytis fruit rot (grey mould)	• Supra Captan 80 WDG or Maestro 80 DF • Ferbam 76 WDG • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG • Switch 62.5 WG • Serenade ASO	2.25 kg/ha 2.25 kg/ha 3.75 kg/1,000 L water 1.7 kg/ha 560 g/ha 560 g/ha 1.3–1.6 kg/ha 775 g/ha 4–15 L/ha	Fungicides for botrytis blights are more important when wet weather occurs. Repeat at 7–10 day intervals through bloom if weather is wet. Choose fungicides from different groups to reduce the development of resistant strains. **Ferbam:** Do not use later than mid-bloom. **Lance, Cantus, Pristine:** These products contain active ingredients in the same fungicide group. Use a maximum of two consecutive applications then alternate with fungicides from a different group. **Serenade ASO:** Provides suppression, rather than control, of botrytis blight. Expect best results from multiple applications or when used in rotation with other products. See notes on *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.

Diseases and Insects	Products	Rate	Comments
Petal fall			
Cherry fruitworm Cranberry fruitworm	• Dipel 2X DF • Assail 70 WP • Rimon 10 EC • Malathion 25 W • Sevin XLR	1.68 kg/ha 160 g/ha 1.35–2 L/ha 2.25 kg/ha 4 L/ha	Moths lay eggs on developing fruit and larvae tunnel into fruit. Spray at petal fall and again in 7–14 days, or, use pheromone traps to monitor moth activity and to time the spray more accurately. If bloom is still present, choose a product with low bee toxicity, such as Dipel, for the petal fall spray. **Dipel:** Spray as soon as possible after peak trap catch has been determined and continue at 3–7 day intervals, to a maximum of four applications. Acidify spray mix to below pH 7.0 and apply on cloudy days or at dusk. See *Biopesticides for Insect Control*, page 247, and notes on *Bacillus thuringiensis var. kurstaki*, page 247. **Assail:** Has activity on eggs and young larvae. Monitor adult flight with pheromone traps and apply as soon as possible after peak trap catch has been determined (when eggs are hatching). Repeat in 10–14 days if trap catches rise again. **Rimon:** Has activity on eggs and young larvae. Spray as soon as possible after peak trap catch has been determined and re-apply in 10–14 days. Apply in sufficient water to ensure good coverage. Rimon may be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid spraying if bees are visiting the treatment area. **Sevin:** Apply 5–7 days after trap catches peak. A second insecticide is required if trap catches remain elevated seven days after application. Use for cranberry fruitworm only. **Malathion:** Apply 5–7 days after trap catches peak. Repeat twice at 4–5 day intervals. A fourth insecticide is required if trap catches remain elevated after last application. Malathion also controls aphids.
White-marked tussock moth	• Bioprotec CAF • Foray 49 BA	4 L/ha 4 L/ha	White-marked tussock moth is a sporadic pest. Larvae devour foliage. Make two applications 2–5 days apart, when larvae are very small, usually just after bloom. A second generation may require control in late summer.
Blueberry aphids	• Assail 70 WP • Concept	56–86 g/ha 560 mL/ha	Aphids are rarely a problem on blueberries at this time. **Concept:** Concept includes active ingredients from two different insecticide groups with two different modes of action: Group 4 (imidacloprid) and Group 3 (deltamethrin). Do not apply following a soil application of Admire or Alias for white grubs. For resistance management, avoid repeated use of Concept, Assail or other products from the same family groups: i.e. Admire, Alias (group 4) or Decis (group 3).
European chafer larvae Japanese beetle larvae	• Admire 240 F or Alias 240 SC	1.2 L/ha 1.2 L/ha	**Admire, Alias:** Do not apply during bloom. Apply just prior to egg hatch (shortly after adults are active) to damp soil around bushes and to grass covered areas around blueberry field. Apply in 200 L water per ha. Move the product into the root zone with 5–10 mm irrigation within 24 hours of application but avoid over watering. Use a maximum of one application per season, at petal fall, green fruit or after harvest. These products will reduce numbers of white grub larvae but may not provide control. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13.

Diseases and Insects	Products	Rate	Comments
Anthracnose fruit rot	• Cabrio EG • Pristine WG • Switch 62.5 WG • Bravo 500 or Echo 720 • Aliette WDG • Allegro 500 F	1.0 kg/ha 1.3–1.6 kg/ha 775 g/ha 7.2 L/ha 5 L/ha 5.6 kg/ha 2.24 L/ha	Most fruit infections occur in the bloom to green fruit stage. Infected fruit soften near harvest time and orange spore masses develop on the fruit. Alternate with fungicides from different groups. **Pristine, Cabrio:** Both include active ingredients in the same fungicide group. Make no more than two consecutive applications, and then alternate with fungicides from different groups. **Bravo, Echo:** Also control alternaria fruit rot. May cause fruit injury if applied to green fruit. **Allegro:** Provides suppression rather than control of anthracnose. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13.
Phomopsis	• Cabrio EG • Pristine WG • Bravo 500 or Echo 720 • Allegro 500 F • Aliette WDG	1 kg/ha 1.6 kg/ha 7.2 L/ha 5 L/ha 2.24 L/ha 5.6 kg/ha	**Pristine, Cabrio:** Both include active ingredients in the same fungicide group. Make no more than two consecutive applications, and then alternate with fungicides from different groups. **Bravo, Echo:** Also control alternaria fruit rot. May cause fruit injury if applied to green fruit. **Allegro, Aliette:** Apply at 14–21 day intervals. Provides suppression rather than control of phomopsis. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13.
Green Fruit			
Obliquebanded leafroller (OBLR)	• Success 480 SC or Entrust 80 W • Delegate WG • Dipel 2X DF	145–182 mL/ha 80–109 g/ha 100–200 g/ha 525–1,125 g/ha	Place pheromone traps in blueberries by early June to monitor adult OBLR. Apply insecticides for summer generation larvae at 240–280 DDC after first sustained moth catch (base 6.1°C). See *Degree-day modeling and determining a biofix,* page 9. **Success, Entrust, Delegate:** Re-apply as necessary on a 7–10 day schedule. **Dipel:** Works best on small larvae. Make two applications at 5–7 day intervals if activity of the larvae is extended. For best results acidify spray mix to below pH 7.0 and apply at dusk or on overcast days See *Biopesticides for Insect Control,* page 247. Many of these products are also labelled for spanworms (known as inchworms or loopers) and other caterpillars. See product label for a complete list of registered uses.
Japanese beetle adults	• Imidan 50 WP	2.25 kg/ha	Apply at the first sign of adult activity. Check pre-harvest intervals. **Imidan:** Do not apply within 15 days of harvest.
European chafer larvae Japanese beetle larvae	• Admire 240 F or Alias 240 SC	1.2 L/ha 1.2 L/ha	**Admire, Alias:** Apply just prior to egg hatch (shortly after adults are active) to damp soil around bushes and to grass covered areas around blueberry field. Apply in 200 L water per ha. Move the product into the root zone with 5–10 mm irrigation within 24 hours of application but avoid over watering. Use a maximum of one application per season, at petal fall, green fruit or after harvest. These products will reduce numbers of white grub larvae but may not provide control. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13.
Fruit ripening			
Spotted wing drosophila	Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into blueberry fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Frequent picking, burial of grade-out fruit, and general sanitation are very important to prevent problems with SWD. Check the OMAFRA website for updates on pest development, registered products and management strategies for control.		
White-marked tussock moth	• Bioprotec CAF or Foray 49 BA	4 L/ha 4 L/ha	White-marked tussock moth is a sporadic pest. Larvae devour foliage. Make two applications 2–5 days apart, when larvae are very small, usually just after bloom. A second generation may require control in late summer.

Diseases and Insects	Products	Rate	Comments
Botrytis fruit rot (grey mould)	• Supra Captan 80 WDG or Maestro 80 DF • Elevate 50 WDG • Lance WDG or Cantus WDG • Switch 62.5 WG • Serenade ASO	2.25 kg/ha 2.25 kg/ha 1.7 kg/ha 560 g/ha 560 g/ha 775 g/ha 4–15 L/ha	Spray at 7–10 day intervals if botrytis grey mould was not well controlled during bloom. Choose fungicides from different fungicide groups to reduce the development of resistant strains. **Serenade ASO:** Provides suppression, rather than control, of botrytis grey mould. Expect best results from multiple applications or when used in rotation with other products. See notes on *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
Anthracnose fruit rot	• Switch 62.5 WG • Cabrio EG • Pristine WG	775 g/ha 1 kg/ha 1.3–1.6 kg/ha	Most infections take place during bloom. Fungicides at this time are not necessary if good control was achieved earlier. **Pristine, Cabrio:** Both include active ingredients in the same fungicide group. Make no more than two consecutive applications, and then alternate with fungicides from different groups.
Blueberry maggot	• Imidan 50 WP • Cygon 480-AG or Lagon 480 E • Malathion 25 W • Sevin XLR • Assail 70 WP • GF-120 NF	2.25 kg/ha 830 mL/ha 825 mL/ha 2.25 kg/ha 4 L/ha 136–160 g/ha 1.5 L/ha	Monitor for blueberry maggot using yellow sticky traps. Blueberry maggot is not widespread in Ontario but it is regulated by the Canadian Food Inspection Agency in several regions (Charlotteville and Wainfleet townships) and on several blueberry farms. Growers in regulated areas should spray for this pest. Growers outside regulated areas should consider border sprays and practice best management practices to prevent infestation. For more information, see Blueberry Maggot at *www.ontario.ca/crops*. Apply the first spray when first blueberry maggots are trapped or when berries begin to turn blue, about July 5–15, depending on the area and season. Apply a second spray about 5–12 days later, depending on the product. Protection is needed as long as adults are active. Imidan and Cygon provide 10–12 days protection under normal conditions. Residual activity of Sevin and Malathion is 5–7 days. **Cygon, Lagon:** Use a maximum of two applications per season. Do not use on crops destined for USA markets. **Assail:** After application, wait at least 12 days before Assail is used again. **Imidan:** Use a maximum of two applications per season. **GF-120 NF:** This is a bait formulation that requires large droplet size (4–6 mm); specialized application equipment may be needed. Begin applications when first blueberry maggot flies are trapped or 2–3 weeks before fruit begins to ripen. Repeat application at least every 7 days. GF-120 will lose effectiveness if exposed to rain or overhead irrigation.

Blueberry maggot is a regulated pest. New infestations must be reported to the Canadian Food Inspection Agency.

Blueberry maggot can spread to new areas in soil, harvest containers, or when infested fruit is purchased from another region and disposed of on your farm.

Use best management practices to prevent spread of blueberry maggot to new areas.

See *www.ontario.ca/crops*.

Table 5-9. Products Used on Blueberries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	**Registration number**	**Common name**	**Group**	**Preharvest interval**	**Minimum re-entry**	**Maximum number applications per season (on label)**
Products used to control or suppress insects and mites						
Admire 240 F	24094	imidacloprid	4	14 days	24 hours	1
Alias 240 SC	28475	imidacloprid	4	14 days	24 hours	1
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours/2 days[1]	4
Bioprotec CAF	26854	*Bacillus thuringiensis*	11	0 days		4
Concept	29611	imidacloprid + deltamethrin	3+4	14 days	24 hours	3
Cygon 480-AG	25651	dimethoate	1B	15 days		2
Decis 5 EC	22478	deltamethrin	3	14 days		
Delegate WG	28778	spinetoram	5	3 days	12 hours	3
Dipel 2X DF	26508	*Bacillus thuringiensis*	11	1 day		4
Entrust 80 W	27825	spinosad	5	3 days		3
Foray 49 BA	24978	*Bacillus thuringiensis*	11			
GF-120 NF	28336	spinosad	5			5
Imidan 50 WP	23006	phosmet	1B	15 days	3 days/15 days[2]	2
Lagon 480 E	9382	dimethoate	1B	15 days		2
Malathion 25 W	14656	malathion	1B	1 day		
Rimon 10 EC	28881	novaluron	15	8 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	2 days		
Purespray Green Spray Oil 13 E	27666	mineral oil		dormant application	12 hours	1
Success 480 SC	26835	spinosad	5	3 days		3
Superior 70 Oil	9542 14981	mineral oil			12 hours	
Products used to control or suppress diseases						
Allegro 500 F	27517	fluazinam	29	30 days	24 hours	4
Aliette WDG	24458	fosetyl al	U	1 day	24 hours	4
Bravo 500	15723	chlorothalonil	M	54 days	48 hours	3
Cabrio EG	27323	pyraclostrobin	11	1 day	12 hours/1 day[3]	4
Cantus WDG	30141	boscalid	7	0 days	12 hours	4
Echo 720	29355	chlorothalonil	M	54 days	48 hours	3
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Ferbam 76 WDG	20136	ferbam	M	40 days		
Funginex DC	27686	triforine	3	60 days	48 hours	3
Jade	24030	propiconazole	3	60 days	72 hours	2
Lance WDG	27495	boscalid	7	0 days	12 hours	4
Lime Sulphur	16465	calcium polysulphide	M	dormant application	48 hours	1
Maestro 80 DF	26408	captan	M	2 days	72 hours	

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period as follows: re-entry/ hand pruning and other hand labour.

[2] Re-entry period as follows: re-entry/ pick-your-own harvest.

[3] Re-entry period as follows: re-entry/ hand harvest.

Table 5-9. Products Used on Blueberries (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number applications per season (on label)
Mission 418 EC	28016	propiconazole	3	60 days	72 hours	2
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days	When dry/ 24 hours[3]	4
Ridomil Gold 480 SL	28474	metalaxyl-M and S	4	80 days	12 hours	1
Serenade ASO	28626	*Bacillus subtilis*	44	0 days		
Supra Captan 80 WDG	24613	captan	M	2 days	72 hours	
Switch 62.5 WG	28189	cyprodinil + fludioxonil	9+12	1 day	12 hours	3
Topas	30163	propiconazole	3	60 days	72 hours	2

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period as follows: re-entry/ hand pruning and other hand labour.

[2] Re-entry period as follows: re-entry/ pick-your-own harvest.

[3] Re-entry period as follows: re-entry/ hand harvest.

Notes on Blueberry Diseases and Insects

For information on the activity of fungicides to blueberry diseases, see Table 5-10. *Activity of Fungicides on Blueberry Diseases,* on this page. For information on the activity of insecticides on blueberry insects, see Table 5-11. *Activity of Insecticides on Blueberry Pests and Bees,* page 100.

Table 5-10. Activity of Fungicides on Blueberry Diseases

Ratings in shaded cells indicate the disease is listed on the product label for control or suppression. Use fungicides only for diseases listed on the product label for the crop and for the disease. Where ratings are not in shaded cells, some activity against this disease is anticipated, but this use is not on the product label. Consult the label for more information. The information provided in this table is intended to assist the grower in choosing the best fungicide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Fungicide group	Product	Mummy berry (shoot blight)	Phomopsis stem canker	Anthracnose fruit rot	Botrytis fruit rot	Alternaria fruit rot	Phytophthora root rot
M	Bravo 500	+	++	++	+	+	0
M	Echo 720	+	++	++	+	+	0
M	Ferbam 76 WDG	+			+	+	0
M	Lime Sulphur		+	+			
M	Maestro 80 DF	+	+	++	+ to ++	+	0
M	Supra Captan 80 WDG	+	+	++	+ to ++	+	0
U	Aliette WDG	0	++	++		++	++
3	Funginex DC	+++	++	0	0	0	0
3	Jade	+++	+	++	0	0	0
3	Mission 418 EC	+++	+	++	0	0	0
3	Topas	+++	+	++	0	0	0
4	Ridomil Gold 480 SL	0	0	0	0	0	+++
7	Cantus WDG	0			+++	++	0
7	Lance WDG	0			+++	++	0
7&11	Pristine WG	+ to ++	+++	+++	+++	++	0
9&12	Switch 62.5 WG	+	+	+++	+++	+++	0
11	Cabrio EG	+	+++	+++	+	+	0
17	Elevate 50 WDG	0	0	0	+++	0	0
29	Allegro 500 F	+	+	+		+	0
44	Serenade ASO	++	+	0	+		0

Use fungicides only for control of diseases listed on the product label.
0 = No control; + = Poor to fair control; ++ = Good control, some limitations; +++ = Excellent control, few if any limitations.
Blank cell = Information is unavailable.
Adopted from several sources including Michigan State Fruit Management Guide 2011.

Table 5-11. Activity of Insecticides on Blueberry Pests and Bees

Ratings in shaded cells indicate the pest is listed on the product label for control or suppression. Use insecticides only for insects listed on the product label for the crop and for the insect. Where ratings are not in shaded cells, some activity against this insect is anticipated, but this use is not on the product label. Consult the label for more information. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Group	Insecticide	Aphids	Blueberry maggot	Cranberry fruitworm Cherry fruitworm	Japanese beetle adults	Leafrollers	Plum curculio	Scale insects	Spotted wing drosophila (adult)	White grubs (larva)	Bee toxicity
1A	Sevin XLR		++	++	+++	+	+	+	+	0	HT
1B	Cygon 480-Ag	++	+++	+++			+		+++	0	HT
1B	Lagon 480 E	++	+++	+++			+		+++	0	HT
1B	Imidan 50 WP		+++	+++	++	+++	+++		+++	0	HT
1B	Malathion 25 W	+	++	++	+	+	++		+++	0	HT
3	Decis 5 EC		+++			++	+		+++	0	HT
4	Admire 240 F	+++	0	0	+				0	++	HT
4	Alias 240 SC	+++	0	0	+				0	++	HT
4	Assail 70 WP	+++	+++	++	++		+		+	0	MT
3&4	Concept	+++	++	++					++	0	HT
5	Delegate WG			+++	0	+++	+	0	+++	0	HT
5	GF-120 NF	0	++	0	0	0	0	0		0	HT
5	Entrust 80 W		+++	+++	0	+++	0	0	+++	0	HT
5	Success 480 SC		+++	+++	0	+++	0	0	+++	0	HT
11	Dipel 2X DF	0	0	+	0	++	0	0	0	0	S
11	Bioprotec CAF	0	0	+	0	++	0	0	0	0	S
11	Foray 48BA	0	0	+	0	++	0	0	0	0	S
15	Rimon 10 EC			+++	0	+++	0			0	MT*
	Purespray Green Spray Oil 13E	++	0	0	0	0	0	+++	0	0	
	Superior 70 Oil	++	0	0	0	0	0	+++	0	0	

Bee toxicity: HT = highly toxic; MT = moderately toxic; S = relatively safe or non-toxic.

* Rimon may be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid spraying if bees are visiting the treatment area.

0 = No control; + = Poor to fair control; ++ = Good control,; +++ = Excellent control.

NA = Not used at the timing for this pest.

Blank cell = Information is unavailable.

Adopted from several sources including Michigan State Fruit Management Guide 2011.

Currant and Gooseberry Calendar

Read the product label and follow all safety precautions.

Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point.

Products are listed according to insecticide and fungicide family groups. Use of products from different groups helps prevent the development of pest resistance. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides*, page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 5-12. *Products Used on Currants*, page 103.

Diseases and Insects	Products	Rate	Comments
Just before blossoms open			
	DO NOT APPLY INSECTICIDES WHILE CURRANTS OR GOOSEBERRIES ARE IN BLOOM. SEE *BEE POISONING* ON PAGE 267.		
Sawfly (imported currant fruitworm)	• Diazinon 50 WSP or Diazinon 500 E	1 kg/1,000 L water 1 L/1,000 L water	Adults lay eggs in May and June. Green larvae quickly devour foliage at the green fruit stage. Gooseberries are the preferred host; black currants are not attacked. Do not apply Diazinon after the first bloom opens.
Aphids	• Malathion 25 W • Assail 70 WP	2–2.5 kg/1,000 L water 56–86 g/ha	Currant blister aphid feeds on new growth, causing leaf curl and red blisters. Spray if aphids are abundant. Ensure good coverage of undersides of curled leaves. Do not apply during bloom of crops or weeds in treatment area.
Leaf spot	• Ferbam 76 WDG • Copper 53 W plus hydrated lime	6.75 kg/ha 5 kg /1,000 L plus 4 kg lime/1,000 L	Leaf spots develop on susceptible varieties, reducing yield and vigour. Rake or cultivate to bury old infected leaves before bud-break. Apply fungicides to susceptible varieties at weekly intervals if weather is wet. Ferbam is not labelled for gooseberries.
Powdery mildew	• Microscopic Sulphur • Pristine WG	5 kg/ha 1.6 kg/ha	Resistant varieties are available, see Table 5-13. *Disease Ratings on Selected Currant and Gooseberry Varieties*, page 103. Prune out infected twig tips in fall and avoid excessive nitrogen. **Pristine** is registered for suppression, rather than control of powdery mildew.
Botrytis grey mould	• Pristine WG • Lance WDG or Cantus WDG • Elevate 50 WDG • Serenade ASO	1.3–1.6 kg/ha 560 g/ha 560 g/ha 1.7 kg/ha 4–15 L/ha	*Botrytis* infection during bloom causes early fruit drop, or "runoff" in currants. Apply fungicides at 7–10 day intervals during bloom. Choose fungicides from different fungicide groups to reduce the development of resistant strains of *Botrytis*. **Pristine, Lance, Cantus:** These products include active ingredients in the same fungicide group. Do not alternate Pristine with Lance or Cantus. **Serenade ASO:** Provides suppression, rather than control. Expect best results when used in multiple applications or rotation with other products. See notes on *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
Bloom			
Botrytis grey mould	Apply one of the fungicides listed at **Just before blossoms open.**		
Postbloom			
Currant fruit fly	• Malathion 25 W	2–2.5 kg/1,000 L water	Larvae infest fruit, causing it to ripen prematurely. Spray to control adult flies, which lay eggs on green fruit. Spray where this pest has been a problem in the past or use yellow sticky traps to monitor for adult activity. Make two applications, 10 days apart. Malathion is most effective when temperature is above 20°C.
Leaf spot	• Ferbam 76 WDG • Copper 53 W plus hydrated lime	6.75 kg/ha 5 kg /1,000 L plus 4 kg lime/1,000 L	Apply at weekly intervals in the spring if weather is wet, but not within 14 days of harvest. Ferbam is not labelled for gooseberries.

Diseases and Insects	Products	Rate	Comments
Powdery mildew	• Microscopic Sulphur • Pristine WG	5 kg/ha 1.6 kg/ha	Resistant varieties are available, see Table 5-13. *Disease Ratings on Selected Currant and Gooseberry Varieties,* page 103. Prune out infected twig tips in fall and avoid excessive nitrogen. If warm and humid conditions persist, spray weekly until fruit begins to colour. Spray fungicides before symptoms develop. Pristine is registered for suppression rather than control of powdery mildew.
Green fruit-preharvest			
Currant fruit fly	• Malathion 25 W	2.5 kg/1,000 L water	Apply at 7–10 days after postbloom. **Malathion:** Most effective when temperature is above 20°C.
Obliquebanded leafroller	• Success 480 SC or Entrust 80 W • Dipel 2X DF	145–182 mL/ha 80–109 g/ha 525–1,125 g/ha	This pest is rarely a problem on currants and gooseberries. **Success, Entrust:** Also control spanworms. **Dipel:** Works best on very small larvae. Acidify spray mix to below pH 7.0 and apply on cloudy days or at dusk. See *Biopesticides for Insect Control,* page 247, and notes on *Bacillus thuringiensis var. kurstaki,* page 247.
Powdery mildew	• Microscopic Sulphur • Pristine WG	5 kg/ha 1.6 kg/ha	Resistant varieties are available, see Table 5-13. *Disease Ratings on Selected Currant and Gooseberry Varieties,* page 103. Prune out infected twig tips in fall and avoid excessive nitrogen. If warm and humid conditions persist, repeat weekly until fruit begins to colour. Spray fungicides before symptoms develop. Pristine is registered for suppression rather than control of powdery mildew.
Leaf spot	• Ferbam 76 WDG • Copper 53 W plus hydrated lime	6.75 kg/ha 5 kg/1,000 L plus 4 kg lime/1,000 L	Apply at 7–10 days after postbloom spray if weather is wet, but not within 14 days of harvest. Ferbam is not labelled for gooseberries.
Postharvest			
Aphids	• Malathion 25 W • Assail 70 WP	2.5 kg/1,000 L water 56–86 g/ha	Monitor for leaf curling on new growth. If these pests are present, spray red and white currants immediately after fruit is picked.
Leafhoppers	• Malathion 25 W	2.5 kg/1,000 L water	Monitor for leaf curling on new growth.
Leaf spot Powdery mildew	If leaf spot or powdery mildew continue to be a problem, spray after harvest with a product listed at **Green fruit-preharvest** to avoid premature defolation.		

Table 5-12. Products Used on Currants

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation beneficial insects.

Product name	Registration number	Common Name	Group	Preharvest interval	Minimum re-entry	Maximum number applications per season (on label)
Products used to control or suppress insects and mites						
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours/2 days[1]	4
Dipel 2X DF	26508	*Bacillus thuringiensis*	11	1 day		
Diazinon 500 E	11889	diazinon	1A	Do not use after first bloom	6 days	
Diazinon 50 WSP	29976	diazinon	1A	Do not use after first bloom	6 days	
Entrust 80 W	27825	spinosad	5	3 days		3
Malathion 25 W	14656	malathion	1B	3 days		
Success 480 SC	26835	spinosad	5	3 days		3
Products used to control or suppress diseases						
Cantus WDG	30141	boscalid	7	0 days	12 hours	4
Copper 53 W	9934	tribasic copper sulphate	M	1 day	48 hours	4
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Ferbam 75 WDG	20136	ferbam	M	14 days		
Lance WDG	27495	boscalid	7	0 days	12 hours	4
Microscopic Sulphur	14653	sulphur	M	1 day	24 hours	8
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days	when dried/ 29 days[2]	4
Serenade ASO	28626	*Bacillus subtilis*	44	0 days		

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period as follows: re-entry / hand pruning and other hand labour.

[2] Re-entry period as follows: re-entry / hand harvest.

Table 5-13. Disease Ratings on Selected Currant and Gooseberry Varieties

Type	Variety	Mildew Resistance	Rust Resistance[1]
black currant	Ben Alder	resistant[2]	very susceptible[2]
	Ben Connan	resistant[2]	moderately resistant[2]
	Ben Sarek	resistant[2]	moderately resistant[2]
	Titania	immune	immune
red currant	Red Lake	susceptible[4]	susceptible[3]
	Rovada	resistant[4]	moderately resistant[3]
	Jonkheer van Tets	moderately resistant[3]	resistant[4]
gooseberry	Captivator	moderately resistant[3]	
	Invicta	moderately resistant[3]	moderately resistant[3]
	Hinnonmaki Red	resistant[4]	moderately resistant[3]

[1] Resistant: Does not show symptoms of rust (only Titania has genetic resistance).
Moderately resistant: Shows symptoms at low frequency, yield not affected.
Susceptible: Noticeable levels of rust infection, not affecting yield.
Very susceptible: Severe infection, affecting yield.

Source:

[2] Adam Dale, *HortTechnology* 10(3) 2000, page 553.

[3] Hummer and Barney, *HortTechnology* 12(3) 2002, page 382–383; or, *Currants, Gooseberries, Jostaberries, Guide for Growers*. Food Products Press 2005.

[4] Dick McGinnis, McGinnis Berry Crops, B.C., personal communication.

Elderberries

Elderberries have few insect and disease pests. Elderberries are in the bushberry crop group and these products registered for bushberries can be used for elderberries. See Table 5-14. *Pest Management Products for Elderberries,* on this page. Not every pest is a problem on elderberries.

Monitor elderberries for pests and diseases, such as aphids, leafhoppers and mites, as well as the pests listed below.

Table 5-14. Pest Management Products for Elderberries

Read the product label and follow all safety precautions.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

Pest	Common name	Product	Rate	Preharvest interval	Re-entry	Comments
Aphids	acetamiprid	Assail 70 WP	56–86 g/ha	7 days	12 hours/ 2 days[1]	Do not apply during bloom. Maximum 4 applications per growing season.
Leafrollers and spanworms	spinosad	Success 480 SC or Entrust 80 W	145–182 mL/ha 80–109 g/ha	3 days	When dry	Use pheromone traps to monitor for leafrollers and spray as soon as possible after peak trap catch, or, spray when very small larvae are present. **Success, Entrust:** Maximum 3 applications per season. **Dipel:** Acidify spray mix to below pH 7.0 and apply on cloudy days or at dusk. See *Biopesticides for Insect Control,* page 247, and notes on *Bacillus thuringiensis var. kurstaki,* page 247.
	Bacillus thuringiensis	Dipel 2X DF	525–1,125 g/ha			
Weevils	thiamethoxam	Actara 25 WG	210–280 g/ha	3 days	12 hours	Apply to crop foliage to control adult weevils. Maximum 2 applications per growing season.
Anthracnose	fluazinam	Allegro 500 F	2.24 L/ha	30 days	24 hours	**Allegro:** Provides suppression rather than control of this disease. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13. Maximum 4 applications per growing season. **Pristine:** Maximum 4 applications per growing season.
	boscalid + pyraclostrobin	Pristine WG	1.3–1.6 kg/ha	0 days	when dry/ 24 hours[2]	
Bacterial blight	*Bacillus subtilis*	Serenade ASO	4–12 L/ha	0 days		Provides suppression rather than control of bacterial blight. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13 and notes on *Bacillus subtilis (Serenade ASO, Serenade MAX),* page 242.
Botrytis	fenhexamid	Elevate 50 WDG	1.7 kg/ha	1 day	4 hours	Begin applications at 10% bloom. **Elevate:** Maximum 4 applications per growing season. **Lance, Cantus:** Maximum 4 applications per growing season. **Pristine:** Maximum 4 applications per growing season. **Serenade ASO:** Provides suppression rather than control. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13 and notes on *Bacillus subtilis (Serenade ASO, Serenade MAX),* page 242.
	boscalid	Lance WDG or Cantus WDG	560 g/ha	0 days	12 hours	
	boscalid + pyraclostrobin	Pristine WG	1.3–1.6 kg/ha	0 days	when dry/ 24 hours[2]	
	Bacillus subtilis	Serenade ASO	4–15 L/ha	0 days		
Phomopsis	boscalid + pyraclostrobin	Pristine WG	1.6 kg/ha	0 days	when dry/ 24 hours[2]	**Pristine:** Maximum 4 applications per growing season.

A blank cell indicates that the information is not specified on the product label.

[1] Re-entry period as follows: re-entry/ hand pruning and other hand labour.

[2] Re-entry period as follows: re-entry/ hand pruning and harvest.

Summer-fruiting Raspberry Calendar

Read the product label and follow all safety precautions.

Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point.

Products are listed according to insecticide and fungicide family groups. Use products from different groups to help prevent development of pest resistance. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 5-15. *Products Used on Raspberries,* page 111.

Diseases and Insects	Products	Rate	Comments
Delayed dormant to green tip			
Spur blight Cane blight	• Lime sulphur	26 L/1,000 L water	This spray reduces overwintering inoculum and is the first step in a good disease control program. Spray enough water to drip off the plants. Do not use lime sulphur later than ¼-inch green.
Prebloom (until blossoms open)			
Anthracnose Spur blight	• Ferbam 76 WDG • Tanos 50 DF	2.5 kg/1,000 L water 840 g/ha	Protect new growth. Apply when new canes are 25–30 cm tall and again just before first bloom.
Powdery mildew	• Senator 70 WP	500 g/1,000 L water or 1.1 kg/ha	In problem areas, spray when mildew is first observed. Repeat in 7–10 days. For resistance management, use a maximum of two applications per season.
Raspberry sawfly	• Diazinon 50 WSP	1 kg/1,000 L water	These green bristly larvae feed between the veins on new growth causing long holes and shredding. Apply when damage appears, but before first bloom. Diazinon also controls aphids and raspberry fruitworm.
Raspberry fruitworm	• Malathion 25 W • Diazinon 50 WSP	4–5 kg/1,000 L water 1 kg/1,000 L water	These small brown beetles feed on new growth and blossom clusters. Larvae infest the fruit cup. Spray to control adults when damage appears but before first bloom. Repeat in 7–10 days where there is a history of injury.
Obliquebanded leafroller	• Delegate WG • Success 480 SC or Entrust 80 W • Foray 48BA or Bioprotec CAF or Dipel 2X DF	200 g/ha 145–182 mL/ha 80–109 g/ha 1.4–2.8 L/ha 1.4–2.8 L/ha 550–1,125 g/ha	Leafrollers are not usually a problem in Ontario. **Dipel, Foray, Bioprotec:** Spray when larvae are very small and repeat at 3–7 day intervals, to a maximum of four applications. Acidify spray mix to below pH 7.0 and apply on cloudy days or evening. See *Biopesticides for Insect Control,* page 247, and notes on *Bacillus thuringiensis var. kurstaki,* page 247. **Delegate, Success, Entrust:** Apply to eggs and small larvae.
Clipper weevil	• Malathion 25 W	4–5 kg/1,000 L water	Shake blossom clusters over a tray or dish and look for small weevils and clipped buds. Spray if adults or damage are easily observed. This pest is more common where strawberries are grown nearby.
Two-spotted spider mite	• Apollo SC • Acramite 50 WS	500 mL/ha 851 g/ha	Thorough spray coverage of the lower leaf surface is required. **Apollo:** Apollo kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are developing, mostly in the egg stage. Use a maximum of one application per season. **Acramite:** Acramite acts quickly on contact with mites. Beneficial mites can be introduced to prevent mite build-up.

Diseases and Insects	Products	Rate	Comments
Bloom			
	DO NOT APPLY INSECTICIDES WHILE RASPBERRIES AND BLACKBERRIES ARE IN BLOOM. SEE *BEE POISONING* ON PAGE 267.		
Botrytis grey mould	• Rovral • Supra Captan 80 WDG or Maestro 80 DF • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG • Switch 62.5 WG • Serenade ASO	2 kg/ha 2.5 kg/ha 2.5 kg/ha 1.7 kg/ha 560 g/ha 560 g/ha 1.3–1.6 kg/ha 775 g/ha 4–15 L/ha	Bloom is the most important time to control botrytis grey mould. Begin at 5–10% bloom and if the weather is wet, repeat every seven days. Choose fungicides from different fungicide groups to reduce the development of resistant strains. **Captan, Maestro:** The rate for Supra Captan 80 WDG and Maestro 80 DF on blackberry is 2.25 kg/ha. These products also control spur blight. **Pristine, Lance, Cantus:** These products include active ingredients in the same group. Do not alternate Pristine with Lance or Cantus. **Serenade ASO:** Provides suppression, rather than control of botrytis grey mould. Expect best results from multiple applications or when used in rotation with other products. See notes on *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
Fire blight	• Bloomtime Biological FD	375–500 g/ha	**Bloomtime:** Provides suppression rather than control of fire blight. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. Apply in a minimum of 1,000–2,000 L water/ha. Make first application at 15%–20% bloom, second application at full bloom to petal fall. Product has specific handling requirements, see label for storage requirements. See also, *Pantoea agglomerans (Bloomtime Biological FD)*, page 243.
Green fruit			
Spotted wing drosophila	Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into raspberry fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Frequent picking, burial of grade-out fruit, and general sanitation are very important to prevent problems with SWD. Check the OMAFRA website for updates on pest development, registered products and management strategies for control.		
Anthracnose Spur blight Cane botrytis	• Tanos 50 DF	840 g/ha	Ensure spray coverage of primocanes in the row. Keep rows narrow by mowing primocanes as they emerge at the row edges. Captan and Maestro used at this timing will also control spur blight.
Obliquebanded leafroller	• Foray 48BA or Bioprotec CAF or Dipel 2X DF • Delegate WG • Success 480 SC or Entrust 80 W	1.4–2.8 L/ha 1.4–2.8 L/ha 550–1,125 g/ha 200 g/ha 145–182 mL/ha 80–109 g/ha	Leafrollers are not usually a problem in Ontario. **Dipel, Foray, Bioprotec:** Spray when larvae are very small and repeat at 3–7 day intervals. Acidify spray mix to below pH 7.0 and apply on cloudy days or evening. See *Biopesticides for Insect Control*, page 247, and notes on *Bacillus thuringiensis var. kurstaki*, page 247. **Delegate, Success, Entrust:** Apply to eggs and small larvae.
Japanese beetle	• Sevin XLR	5.25 L/ha	Apply when adults appear and repeat as necessary at 7–10 day intervals. The preharvest interval is 11 days.
Rose chafers	• Malathion 25 W	4–5 kg/1,000 L water	Spray when adults are active.
Leafhoppers	• Malathion 25 W • Admire 240 F	4–5 kg/1,000 L water 175 mL/ha	Potato leafhopper can be a problem when nearby hay fields are mowed. New plantings are especially susceptible. Monitor for small green nymphs on lower leaf surface. Leafhoppers feed on primocane leaves and cause new growth to turn yellow and curl under. Spray when nymphs are present and symptoms are evident. **Admire:** Do not apply prebloom, during bloom, or when bees are actively foraging. Apply in 300 L water as a foliar spray. May provide suppression rather than control of leafhoppers. Also controls aphids.

Diseases and Insects	Products	Rate	Comments
Raspberry cane borer Red-necked cane borer	• Admire 240 F	467 mL/ha	Raspberry cane borer makes two rings of puncture marks around the top of the cane, causing the primocane to wilt. Spray to control beetles when damage is first observed. Red-necked cane borer attacks the lower primocane causing canes to break off 0.5–1 m above the ground later in the season. If there is a history of this pest, spray when beetles are active. **Admire:** Do not apply prebloom, during bloom, or when bees are actively foraging. Apply in 300 L water/ha as a foliar spray. May provide suppression rather than control.
White grubs (larvae of European chafer)	• Admire 240 F	1.2 L/ha	Apply in young plantings where populations are high. Apply just prior to egg hatch (shortly after adults are active) to damp soil in the plant row and in the alleys, in 200 L water/ha. Move the product into the root zone with 5–10 mm irrigation within 24 hours of application. Use a maximum of 1 application per year. These products will reduce numbers of white grub larvae but may not provide control. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. Do not apply prebloom, during bloom, or when bees are actively foraging.
Two-spotted spider mite	• Acramite 50 WS	851 g/ha	**Acramite** acts quickly on contact with mites. Thorough coverage of both leaf surfaces is necessary for good control.
Preharvest			
Spanworms	• Success 480 SC or Entrust 80 W	145–182 mL/ha 80–109 g/ha	Spanworms, also known as inch-worms or loopers, appear just before harvest on raspberry fruit.
Botrytis grey mould	• Rovral • Supra Captan 80 WDG or Maestro 80 DF • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG • Switch 62.5 WG • Serenade ASO	2 kg/ha 2.5 kg/ha 2.5 kg/ha 1.7 kg/ha 560 g/ha 560 g/ha 1.3–1.6 kg/ha 775 g/ha 4–15 L/ha	Although bloom is the most important time to control botrytis grey mould, preharvest sprays are required if the weather is wet. Choose fungicides from different fungicide groups to reduce the development of resistant strains. **Captan, Maestro:** Also control spur blight. The rate for Supra Captan 80 WDG and Maestro 80 DF on blackberry is 2.25 kg/ha. **Pristine, Lance, Cantus:** These products include active ingredients in the same group. Do not alternate Pristine with Lance or Cantus. **Serenade ASO:** Provides suppression, rather than control, of botrytis grey mould. Expect best results from multiple applications or when used in rotation with other products. See notes on *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
Postharvest			
Anthracnose Spur blight Cane botrytis	• Tanos 50 DF	840 g/ha	Apply once or twice after harvest, to protect primocanes. Ensure spray coverage of primocanes in the row. Narrow rows and good weed control will reduce disease pressure in the row by allowing air flow and faster drying.
Leafhoppers	• Malathion 25 W • Surround WP • Admire 240 F	4–5 kg/1,000 L water 25 kg/ha 175 mL/ha	**Surround:** Apply at 7–14 day intervals when leafhoppers are first detected by monitoring. Use 12.5–25 kg per 500 L of water. For early applications, use 25 kg per 500 L of water. Once a base coat is established, rate can be reduced for follow-up applications to 12.5 kg per 500 L of water. Surround is not recommended when fruit is present or during bloom. See notes on *Kaolin Clay (Surround WP)*, page 247. **Admire:** Also controls aphids.
Two-spotted spider mite	• Agri-Mek 1.9% EC • Nexter • Acramite 50 WS	1 L/ha 600 g/ha 851 g/ha	Check lower leaf surface for mites and webbing. Thorough spray coverage of the lower leaf surface is required. Beneficial mites can be introduced to prevent mite build-up. Alternate miticides between years. **Agri-Mek, Nexter:** Do not use before harvest. **Acramite:** Acts quickly on contact with mites.

Diseases and Insects	**Products**	**Rate**	**Comments**
White grubs (larvae of European chafer)	• Admire 240 F	1.2 L/ha	Apply in young plantings where populations are high. Do not apply during bloom. Apply to damp soil in the plant row and in the alleys, in 200 L water/ha. Move the product into the root zone with 5–10 mm irrigation within 24 hours of application. These products will reduce numbers of white grub larvae but may not provide control. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13.
Special Sprays: Early spring and/or fall			
Raspberry crown borer	• Diazinon 500 E or Diazinon 50 WSP • Guthion 50 WSB or Sniper • Altacor	1 L/1,000 L water 1 kg/1,000 L water 2.25 kg/ha 2.25 kg/ha 215–285 g/ha	If more than 5% of the crowns are infested, spray lower portions of canes and the crown area. Treat infested plantings at least two years in a row. **Diazinon:** Apply diazinon in 4,000–5,000 L of water per ha as a drench to crowns and base of plants. Apply in spring to control young larvae before they tunnel into crowns. Apply when new growth is about 10 cm above ground. Do not apply after first bloom. **Guthion, Sniper:** Registration will be withdrawn in 2013. Do not use after December 31, 2012. Apply in mid-September to mid-October to control young larvae. Apply in 1,600 L of water per ha. **Altacor:** Apply to first-instar when they are actively feeding in the cambium, before they tunnel into the root, crown or canes. Re-apply, if necessary, at 14-day intervals.
Phytophthora root rot	• Ridomil Gold 480 SL	37 mL/100 m of row (Apply in a drench spray to the soil surface in a 1 m band centered over the row).	**Ridomil:** In new, non-bearing plantings, apply as a soil drench after planting and again in mid to late October (before the ground is frozen). In established plantings, apply Ridomil Gold in the fall only. Do not apply in the spring before harvest. Use at least 2,500 L of water per ha.
	• Aliette WDG	5.50 kg/ha	**Aliette:** Use Aliette as a preventive treatment. Use a maximum of four applications per year: two in the spring and two in the fall. **Spring application:** Apply after bud break at 7 cm of new growth and again 3–4 weeks later. Do not apply within 60 days of harvest. **Fall application:** Apply when conditions favour disease development (high soil moisture and cool temperatures) and repeat if necessary 3–4 weeks later. The last application should be made at least 30 days before leaf drop. **Precautions:** Crop phytotoxicity is possible when Aliette is mixed with copper. Care should be taken if mixing Aliette with nitrogen-based foliar fertilizer. Incompatibility with some suspension concentrate formulations can occur.

Fall-bearing Raspberry Calendar (primocane fruiting)

This calendar is for primocane-fruiting raspberry varieties, that fruit on the tips of the current year's growth, and are mowed annually.

Read the product label and follow all safety precautions.

Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point.

Products are listed according to insecticide and fungicide family groups. Use products from different groups to help prevent development of pest resistance. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 5-15. *Products Used on Raspberries,* page 111.

Diseases and Insects	Products	Rate	Comments
Primocanes emerge			
Anthracnose Spur blight	• Ferbam 76 WDG • Tanos 50 DF	2.5 kg/1,000 L water 840 g/ha	Cane diseases are rarely a problem in primocane-fruiting varieties because old canes are mowed down in spring, removing most inoculum. If cane diseases are a perennial problem, apply when new canes are 25–30 cm tall and again in 10 days. Continue at 10-14 day intervals until just before first bloom.
Raspberry sawfly	• Diazinon 50 WSP	1 kg/1,000 L water	These green bristly larvae feed between the veins on new growth causing long holes and shredding. Apply when damage appears, but before first bloom. Diazinon also controls aphids and raspberry fruitworm.
Obliquebanded leafroller	• Delegate WG • Success 480 SC or Entrust 80 W • Foray 48BA or Bioprotec CAF or Dipel 2X DF	200 g/ha 145–182 mL/ha 80–109 g/ha 1.4–2.8 L/ha 1.4–2.8 L/ha 550–1,125 g/ha	Leafrollers are not usually a problem in Ontario. Considerable damage can occur without crop loss. **Dipel, Foray and Bioprotec:** Spray when larvae are very small and repeat at 3–7 day intervals. Acidify spray mix to below pH 7.0 and apply on cloudy days or evening. See *Biopesticides for Insect Control,* page 247, and notes on *Bacillus thuringiensis var. kurstaki,* page 247. **Delegate, Success, Entrust:** Apply to eggs and small larvae.
Two-spotted spider mite	• Apollo SC • Acramite 50 WS	500 mL/ha 851 g/ha	Thorough spray coverage of the lower leaf surface is required. **Apollo:** Apollo kills mite eggs and very young nymphs, but not older nymphs and adults. Apply early in the season. **Acramite:** Acramite acts quickly on contact with mites. Apply when monitoring indicates mite are building up, and mostly in the nymph stages. Beneficial mites can be introduced to prevent mite build-up.
Prebloom			
Japanese beetle	• Sevin XLR	5.25 L/ha	Apply when adults appear and repeat as necessary at 7–10 day intervals. Do not apply during bloom.
Rose chafers	• Malathion 25 W	4–5 kg/1,000 L water	Spray when adults are active, but not during bloom.
Leafhoppers	• Malathion 25 W	4–5 kg/1,000 L water	Potato leafhopper can be a problem when nearby hay fields are mowed. New plantings are especially susceptible. Monitor for small green nymphs on lower leaf surface. Leafhoppers feed on primocane leaves and cause new growth to turn yellow and curl under. Spray when nymphs are present and symptoms are evident. Do not apply during bloom.
Bloom (Mid-July to August)			
DO NOT APPLY INSECTICIDES WHILE RASPBERRIES AND BLACKBERRIES ARE IN BLOOM. SEE *BEE POISONING* ON PAGE 267.			

Diseases and Insects	Products	Rate	Comments
Botrytis grey mould	• Rovral • Supra Captan 80 WDG or Maestro 80 DF • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG • Switch 62.5 WG • Serenade ASO	2 kg/ha 2.5 kg/ha 2.5 kg/ha 1.7 kg/ha 560 g/ha 560 g/ha 1.3–1.6 kg/ha 775 g/ha 4–15 L/ha	Bloom is the most important time to control botrytis grey mould. Begin at 5–10% bloom and if the weather is wet, repeat every 7–10 days. Choose fungicides from different fungicide groups to reduce the development of resistant strains. **Captan, Maestro:** Also control spur blight. **Pristine, Lance, Cantus:** These products include active ingredients in the same group. Do not alternate Pristine with Lance or Cantus. **Serenade ASO:** Provides suppression, rather than control of botrytis grey mould. Expect best results from multiple applications or when used in rotation with other products. See notes on *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
Fire blight	• Bloomtime Biological FD	375–500 g/ha	**Bloomtime:** Provides suppression only. Does not provide control of fire blight. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. Apply in a minimum of 1,000–2,000 L water/ha. Make first application at 15%–20% bloom, second application at full bloom to petal fall. Product has specific handling requirements, see label for storage requirements. See also, *Pantoea agglomerans (Bloomtime Biological FD)*, page 243.
Bloom to Green fruit			
Raspberry cane borer Red-necked cane borer	Products registered for cane borers cannot be used during bloom. Therefore, they are not suitable for primocane fruiting raspberries which have a prolonged bloom period. Prune out and remove old canes during the dormant period to reduce populations of larvae inside the cane. Clear out all wild raspberries around your farm, because these are good hosts for cane borers.		
Two-spotted spider mite	• Acramite 50 WS	851 g/ha	Thorough spray coverage of the lower leaf surface is required. Acramite acts quickly on contact with mites. Apply when monitoring indicates mites are building up, and mostly in the nymph stages. Do not spray when bees are active. Beneficial mites can be introduced to prevent mite build-up.
Preharvest			
Spotted wing drosophila	Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into raspberry fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Fall-bearing raspberries are especially susceptible to this pest. Frequent picking, burial of grade-out fruit, and general sanitation are very important to prevent problems with SWD. Check the OMAFRA website for updates on pest development, registered products and management strategies for control.		
Botrytis grey mould	• Rovral • Supra Captan 80 WDG or Maestro 80 DF • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG • Switch 62.5 WG • Serenade ASO	2.0 kg/ha 2.5 kg/ha 2.5 kg/ha 1.7 kg/ha 560 g/ha 560 g/ha 1.3–1.6 kg/ha 775 g/ha 4–15 L/ha	Although bloom is the most important time to control botrytis grey mould, preharvest sprays are required if the weather is wet. Choose fungicides from different fungicide groups to reduce the development of resistant strains. **Captan, Maestro:** Also control spur blight. **Pristine, Lance, Cantus:** These products include active ingredients in the same group. Do not alternate Pristine with Lance or Cantus. **Serenade ASO:** Provides suppression, rather than control, of botrytis grey mould. Expect best results from multiple applications or when used in rotation with other products. See notes on *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
Harvest			
Botrytis grey mould	Although bloom is the most important time to control botrytis grey mould, harvest sprays are required if the weather is wet. Choose a product for botrytis listed at **Preharvest** but observe the preharvest intervals. Choose fungicides from different groups to reduce the development of resistant strains.		

Diseases and Insects	Products	Rate	Comments
Special Sprays: Early spring and/or fall			
Raspberry crown borer	Prune out old canes close to the ground when plants are dormant. If raspberry crown borer is a problem, see control options under **Summer-fruiting Raspberries, Special sprays,** page 108.		
Phytophthora root rot	If Phytophthora is a problem see control options under **Red Raspberries, Special sprays,** page 108.		

Table 5-15. Products Used on Raspberries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number applications per season (on label)
Products used to control or suppress insects and mites						
Admire 240 F	24094	imidacloprid	4	4 days/14 days[1]	24 hours	1/3[2]
Agri-Mek 1.9% EC	24551	abamectin	6	Use after harvest		2
Acramite 50 WS	27925	bifenazate	25	1 day	12 hours	1
Altacor	28981	clorantraniliprole	28	3 days	12 hours	2/3[3]
Apollo SC	21035	clofentezine	10	15 days	12 hours	1
Bioprotec CAF	26854	*Bacillus thuringiensis*	11	1 day		
Delegate WG	28778	spinetoram	5	1 day	12 hours	3
Diazinon 500 E	11889	diazinon	1B	Use only before bloom	6 days	
Diazinon 50 WSP	29976	diazinon	1B	Use only before bloom	6 days	
Dipel 2X DF	26508	*Bacillus thuringiensis*	11	1 day		
Entrust 80 W	27825	spinosad	5	3 days		3
Foray 48BA	24978	*Bacillus thuringiensis*	11	1 day		
Guthion 50 WSB **	21374	azinphosmethyl	1B	Use after harvest	7 days	1
Malathion 25 W	14656	malathion	1B	1 day		
Nexter	25135	pyridaben	21	Use after harvest	24 hours	2
Sevin XLR	27876	carbaryl	1A	11 days		
Sniper **	23323	azinphosmethyl	1B	Use after harvest	7 days	1
Success 480 SC	26835	spinosad	5	3 days		3
Surround WP	27469	kaolin		1 day		
Vydate L	17995	oxamyl	1A	Use after harvest	72 hours	1

A blank cell indicates the information is not specified on the product label.

[1] Preharvest interval is as follows: 4 days for foliar spray/14 days for soil drench.

[2] Maximum # applications per season: 1 soil drench/3 foliar applications.

[3] Maximum # applications per season: high rate/low rate.

[4] Re-entry period as follows: re-entry/ hand pruning, harvest or other hand labour.

** Registration will be withdrawn in 2013. Do not use after December 31, 2012.

Table 5-15. Products Used on Raspberries (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number applications per season (on label)
Products used to control or suppress diseases						
Aliette WDG	24458	fosetyl al	U	60 days		4
Bloomtime Biological FD	28436	*Pantoea agglomerans,* strain E325	Not classified (biological)	0 days	4 hours	2
Cantus WDG	30141	boscalid	7	0 days	12 hours	4
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Ferbam 76 WDG	20136	ferbam	M	Use only before bloom		3
Lance WDG	27495	boscalid	7	0 days	12 hours	4
Lime Sulphur	16465	calcium polysulphide	M	Do not use after 1/4 inch green	48 hours	
Maestro 80 DF	26408	captan	M	2 days	72 hours	
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days	When dry/ 24 hours[4]	4
Ridomil Gold 480 SL	28474	metalaxyl-M and S	4	Use after harvest	12 hours	1
Rovral	15213	iprodione	2	1 day	12 hours	8
Senator 70 WP	25343	thiophanate-methyl	1	1 day		
Serenade ASO	28626	*Bacillus subtilis*	44	0 days		
Supra Captan 80 WDG	24613	captan	M	2 days	72 hours	
Switch 62.5 WG	28189	cyprodinil + fludioxonil	9+12	1 day	12 hours	3
Tanos 50 DF	27435	cymoxanil + famoxadone	11+27	0 days	24 hours	6

A blank cell indicates the information is not specified on the product label.

[1] Preharvest interval is as follows: 4 days for foliar spray/14 days for soil drench.

[2] Maximum # applications per season: 1 soil drench/3 foliar applications.

[3] Maximum # applications per season: high rate/low rate.

[4] Re-entry period as follows: re-entry/ hand pruning, harvest or other hand labour.

** Registration will be withdrawn in 2013. Do not use after December 31, 2012.

Notes on raspberry diseases and insects

For information on the activity of fungicides on raspberry diseases, see Table 5-16. *Activity of Fungicides on Raspberry Diseases,* on this page.

For information on the activity of insecticides on raspberry pests, see Table 5-17. *Activity of Insecticides on Raspberry Pests and Bees,* page 114.

Table 5-16. Activity of Fungicides on Raspberry Diseases

Ratings in shaded cells indicate the disease is listed on the product label for control or suppression. Use fungicides only for diseases listed on the product label for the crop and for the disease. Where ratings are not in shaded cells, some activity against this disease is anticipated, but this use is not on the product label. Consult the label for more information. The information provided in this table is intended to assist the grower in choosing the best fungicide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Fungicide group	Product	Anthracnose (elsinoe)	Spur blight	Cane botrytis	Botrytis fruit rot	Raspberry leaf spot	Late leaf rust	Powdery mildew	Phytophthora root rot	Crown gall	Fire blight
M	Ferbam 76 WDG	+	+	+	NA		+*		0	0	0
M	Lime Sulphur	+	+	+	0	+	+*		0	0	0
M	Maestro 80 DF	++	++	+	++	+ to ++	0		0	0	0
M	Supra Captan 80 WDG	++	++	+	++	+ to ++	0		0	0	0
1	Senator 70 WP	++	++	+	0 to +	++	0	++	0	0	0
2	Rovral			+	++	0	0		0	0	0
4	Ridomil Gold 480 SL	0	0	0	0	0	0	0	+++	0	0
7	Cantus WDG		0		+++		0		0	0	0
7	Lance WDG		0		+++		0		0	0	0
7&11	Pristine WG	+++	+++	+++	+++	+++	+++	+++	0	0	0
9&12	Switch 62.5 WG			+++	+++			+	0	0	0
11&27	Tanos DF	++	++	+	+						0
17	Elevate 50 WDG		+	+++	+++	0	0		0	0	0
44	Serenade ASO				+			++			0
U	Aliette WDG	0	0	0	0	0	0	0	++	0	0
NC	Bloomtime Biological FD	0	0	0	0	0	0	0	0	0	+

0 = No control; + = Poor to fair control; ++ = Good control, some limitations; +++ = Excellent control, few if any limitations.
Blank cell = Information is unavailable; NA = Not used at the timing for this pest.
* Delayed dormant timing.

Table 5-17. Activity of Insecticides on Raspberry Pests and Bees

Ratings in shaded cells indicate the pest is listed on the product label for control or suppression. Use insecticides only for insects listed on the product label for the crop and for the insect. Additional information is provided in this table to assist the grower in choosing the best insecticide for control of pests listed on the product label. Where ratings are not in shaded cells, some activity against this insect is anticipated, but this use is not on the product label. Consult the label for more information. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Group	Insecticide	Raspberry sawfly	Raspberry fruitworm (beetle)	Leafrollers	Clipper weevil	Leafhoppers	Spider mites	Inchworms and loopers	Rose chafer	Raspberry cane borer	Raspberry crown borer (larvae)	Japanese beetle (adults)	Spotted wing drosophila (adult)	Bee toxicity
1A	Sevin XLR		+	++		++	0	++	++	+	0	+++	+	HT
1B	Diazinon* (various formulations)	+++	+++	++	+	+	0	NA	NA	++	+++	NA	NA	HT
1B	Guthion or Sniper**	NA	NA	NA	NA	NA	NA	NA	NA	NA	+++	NA	NA	HT
1B	Malathion 25 W	+++	+++	++	++	++	0	++	++	++	NA	++	++	HT
4	Admire 240 F		++		++	++	0		++	++	NA	++		HT
5	Delegate WG			+++			0	++			NA		+++	HT
5	Entrust 80 W			+++			0	++			NA		+++	HT
5	Success 480 SC			+++			0	++			NA		+++	HT
6	Agri-Mek 1.9% EC***	0	0	0	0	0	+++	0	0	0	0	0	0	HT
10	Apollo SC	0	0	0	0	0	++	0	0	0	0	0	0	S
11	Bioprotec CAF	0	0	++	0	0	0	+	0	0	0	0	0	S
11	Dipel 2X DF	0	0	++	0	0	0	+	0	0	0	0	0	S
11	Foray 48BA	0	0	++	0	0	0	+	0	0	0	0	0	S
21	Nexter***	0	0	0	0	0	+++	0	0	0	0	0	0	HT
25	Acramite 50 WS	0	0	0	0	0	+++	0	0	0	0	0	0	MT
28	Altacor			+++			0	+++			++	+		S
-	Surround WP					++	+				0			I

* Not for use after bloom.

** For use in September to October only. Registration will be withdrawn in 2013. Do not use after December 31, 2012.

*** For post harvest use only.

Bee toxicity: HT = highly toxic; MT = moderately toxic; S = relatively safe or non-toxic; I = irritant.

0 = No control; + = Poor to fair control; ++ = Good control, some limitations; +++ = Excellent control, few if any limitations.

NA = Not used at the timing for this pest.

Blank cell = Information is unavailable.

Saskatoon Berry Calendar

Read the product label and follow all safety precautions.

Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

Products are listed according to insecticide and fungicide family groups. Use products from different groups to help prevent pest resistance. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 5-18. *Products Used on Saskatoon Berries,* page 117.

Diseases and Insects	Products	Rate	Comments
Early bud break			
Saskatoon bud moth Fruit tree leafroller	• Superior 70 Oil	20 L/1,000 L water	Apply in high water volume until all plant surfaces are coated. Do not apply in freezing weather or if frost is expected.
Flower bud break			
Obliquebanded leafroller Winter moth Fruit tree leafroller Spanworm	• Success 480 SC or Entrust 80 W • Dipel 2X DF	145–182 mL/ha 80–109 g/ha 525–1,125 g/ha	Not all products are labelled for all pests. **Success, Entrust:** Use for obliquebanded leafroller, spanworm, wintermoth. **Dipel:** Use for most leafrollers.
Saskatoon-juniper rust	• Funginex DC • Pristine WG	3 L/ha 1.6 kg/ha	This disease causes yellow spots and swellings on leaves and fruit. Infections on juniper spread up to 2 km to saskatoons. Prune out rust galls on juniper or remove entire juniper plants to reduce disease pressure. Spray fungicides before symptoms develop on saskatoons. **Funginex:** Make one application, between flower bud break and white tip. Do not apply within 60 days of harvest.
Entomosporium leaf and berry spot	• Funginex DC • Kumulus DF or Microthiol Disperss • Switch 62.5 WG • Pristine WG	3 L/ha 7.5 kg/ha 7.5 kg/ha 775–975 g/ha 1.6 kg/ha	Angular brown spots develop first on lower leaves, causing yellowing, defoliation and fruit cracking. Spray fungicides before symptoms develop. Apply at flower bud break and repeat at 10–14 day intervals while disease risk persists. **Funginex:** Make one application between flower bud break and white tip. Do not apply within 60 days of harvest. **Kumulus, Microthiol Disperss:** Do not apply if temperatures are over 27°C or leaf injury may result. **Switch:** For suppression of entomosporium leaf spot.
White tip			
Saskatoon-juniper rust	• Topas or Jade or Mission 418 EC • Pristine WG	500 mL/ha 500 mL/ha 300 mL/ha 1.6 kg/ha	For resistance management alternate products from different fungicide groups.
Entomosporium leaf and berry spot	• Topas or Jade or Mission 418 EC • Kumulus DF or Microthiol Disperss • Switch 62.5 WG • Pristine WG	500 mL/ha 500 mL/ha 300 mL/ha 7.5 kg/ha 7.5 kg/ha 775–975 g/ha 1.6 kg/ha	Repeat at 10–14 day intervals while disease risk persists. For resistance management alternate products from different fungicide groups. **Kumulus, Microthiol Disperss:** Do not apply if temperatures are over 27°C or leaf injury may result. **Switch:** For suppression of entomosporium leaf spot.
Bloom			
Powdery mildew	• Nova 40 W	113 g/ha	Apply before disease symptoms develop. Apply in 1,000 L water per ha, until plants are dripping. Repeat application in 10 days if necessary. Apply no more than 340 g/ha per season. This product is in the same fungicide group as Topas, Jade or Mission and Funginex, and should be used in alternation with products from other groups for entomosporium leaf and berry spot control.

Diseases and Insects	Products	Rate	Comments
Fire blight	• Bloomtime Biological FD	375–500 g/ha	Suppression only. Does not provide control of fire blight. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13. Apply in a minimum of 1,000–2,000 L water/ha. Make first application at 15%–20% bloom, second application at full bloom to petal fall. Product has specific handling requirements, see label for storage requirements. See also, *Pantoea agglomerans (Bloomtime Biological FD),* page 243.
Petal fall			
Saskatoon-juniper rust	• Topas or Jade or Mission 418 EC • Pristine WG	500 mL/ha 500 mL/ha 300 mL/ha 1.6 kg/ha	Infections on juniper spread up to 2 km to saskatoons. Prune out rust galls on juniper or remove entire juniper plants to reduce disease pressure. Spray fungicides before symptoms develop on saskatoons. For resistance management alternate products from different fungicide groups.
Entomosporium leaf and berry spot	• Topas or Jade or Mission 418 EC • Kumulus DF or Microthiol Disperss • Switch 62.5 WG • Pristine WG	500 mL/ha 500 mL/ha 300 mL/ha 7.5 kg/ha 7.5 kg/ha 775–975 g/ha 1.6 kg/ha	For resistance management alternate products from different fungicide groups. **Switch:** For suppression of entomosporium leaf spot.
Green fruit			
Powdery mildew	Apply one of the products listed at **Bloom**.		
Saskatoon-juniper rust	Apply one of the fungicides listed at **Petal fall**.		
Entomosporium leaf and berry spot	Apply one of the fungicides listed at **Petal fall**.		
Special sprays (when monitoring indicates the need)			
Aphids	Assail 70 WP	56–86 g/ha	Aphids are not normally a problem in Saskatoon berries. Apply when aphid populations are high, but not during bloom, due to bee toxicity. This spray does not control root-feeding woolly elm or apple aphids.
After Harvest			
Woolly elm aphid Woolly apple aphid	• Orthene 75 % SP • Admire 240 F	For each plant: 1.7 g For each plant: 0.125 mL	These aphids feed on plant roots and reduce plant vigour. After harvest dig up suspect bushes and examine the root systems for waxy white aphid colonies. Young plantings are especially susceptible. Make one application in mid-July to mid-August, after harvest is complete. **Orthene:** Application is by soil injection. Mix 0.85 g/L of water. Apply 2 L of this solution per plant. Inject in 3–5 injection points about 12 inches deep. See product label for special application instructions. **Admire 240 F:** Apply in 200 L water/ha to the soil at the base of each plant, followed by sufficient water to move the product to the root zone. Admire provides suppression rather than control of woolly aphids. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13.

Table 5-18. Products Used on Saskatoon Berries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season (on label)
Products used to control or suppress insects and mites						
Admire 240 F	24094	imidacloprid	4	14 days	24 hours	1
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours/2 days[1]	4
Dipel 2X DF	26508	*Bacillus thuringiensis*	11	1 day		4
Entrust 80 W	27825	spinosad	5	3 days		3
Orthene 75 % SP	14225	acephate	1B	11 months	72 hours	1
Success 480 SC	26835	spinosad	5	3 days		3
Superior 70 Oil	9542	mineral oil		Apply no later than ¼-inch green	12 hours	1
Products used to control or suppress diseases						
Bloomtime Biological FD	28436	*Pantoea agglomerans* strain E325	Not classified	0 days	4 hours	2
Funginex DC	27686	triforine	3	60 days	48 hours	1
Jade	24030	propiconazole	3	38 days	72 hours	3
Kumulus DF	18836	sulphur	M	1 day	24 hours	8
Microthiol Disperss	29487	sulphur	M	1 day	24 hours	8
Mission 418 EC	28016	propiconazole	3	38 days	72 hours	3
Nova 40 W	22399	myclobutanil	3	14 days		3
Pristine WG	27985	boscalid and pyraclostrobin	7+11	0 days	When dry/ 29 days[2]	4
Switch 62.5 WG	28189	cyprodinil and fludioxonil	9+12	1 day	12 hours/10 days[3]	3
Topas	30163	propiconazole	3	38 days	72 hours	3

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period as follows: re-entry/hand thinning, hand pruning.

[2] Re-entry period as follows: re-entry/ hand harvest.

[3] Re-entry period as follows: re-entry/hand harvest, thinning or pruning.

Sea Buckthorn

Sea buckthorn has few insect and disease pests. Sea buckthorn is in the bushberry crop group and these products registered for bushberrries can be used on sea buckthorn (Table 5-19. *Pest Management Products for Sea Buckthorn*, on this page).

Monitor sea buckthorn for pests and diseases, such as aphids, leafhoppers and mites, as well as the pests listed below.

Table 5-19. Pest Management Products for Sea Buckthorn

Read the product label and follow all safety precautions.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

Pest	Common name	Product	Rate	Preharvest Interval	Re-entry	Comments
Weevils	thiamethoxam	Actara 25 WG	210–280 g/ha	3 days	12 hours	Apply to crop foliage to control adult weevils. Maximum 2 applications per growing season.
Leafrollers and spanworms	spinosad	Success 480 SC or Entrust 80 W	145–182 mL/ha 80–109 g/ha	3 days		Use pheromone traps to monitor for leafroller and spray at peak trap catch, or, spray when very small larvae are present. Not all products are registered for both leaforllers and spanwoms. **Dipel:** Use for leafrollers **Success, Entrust:** Use for obliquebanded leafroller and spanworm.
	Bacillus thuringiensis var. kurstaki	Dipel 2X DF	525–1,125 g/ha	1 day		
Aphids	acetamiprid	Assail 70 WP	56–86 g/ha	7 days	12 hours/ 2 days[1]	Maximum 4 applications per season.
Gypsy moth	*Bacillus thuringiensis* var. *kurstaki*	Bioprotec CAF	2.4–4 L/ha	0 days		Apply when caterpillars first appear, as indicated by monitoring. Treat when larvae are young, before damage is evident, and at times when larvae are actively feeding on treated surfaces. Repeat at 3–14 day intervals, as needed See *Biopesticides for Insect Control*, page 247 and notes on *Bacillus thuringiensis var. kurstaki*, page 247.
Brown rot	sulphur	Microscopic Sulphur	6.5 kg/1,000 L water/ha	7 days	24 hours	For orchards with a history of brown rot, begin applications at the beginning of bloom if weather conditions are conducive to disease development (e.g. warm, wet conditions). Repeat at 7–10 day intervals as needed. Use a maximum of 8 applications per year.
Botrytis	*Bacillus subtilis*	Serenade ASO	4–15 L/ha	0 days		Provides suppression rather than control. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, and notes on *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
Bacterial blight			4–12 L/ha	0 days		

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period as follows: re-entry/hand harvest.

Non-bearing Strawberry Calendar (planting year)

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

Products are listed according to insecticide and fungicide family groups. Use products from different groups to help prevent pest resistance. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides*, page 253.

For information on strawberry pest identification, monitoring and thresholds, see *ONTARIO CropIPM: Integrated Pest Management Training*, available at *www.ontario.ca/cropIPM* or as OMAFRA Publication AF141 in CD format.

For re-entry period, maximum number of applications and chemical group, see Table 5-20. *Products Used on Strawberries*, page 130.

Diseases and Insects	**Products**	**Rate**	**Comments**
May or early June (when new growth begins after transplanting)			
Strawberry aphid	• Admire 240 F • Assail 70 WP	850 mL–1.3 L/ha 56–86 g/ha	Apply when growth begins after transplanting. Do not apply when bloom is present due to bee toxicity. Spray before buds open or after de-blossoming. Choose one of the following products; if further aphid control is required choose products in a different insecticide group. **Admire:** Apply as a soil drench in 2,000 L/ha of water as a surface band directly to the plant row, or apply as a plant hole treatment during transplanting. Make this application with sufficient water to ensure incorporation into the root zone. **Assail:** Apply as a foliar spray. Use a 7-day interval between sprays. Use the high rate under heavy pest pressure.
Leafrollers	• Malathion 25 W	2.75–4.25 kg/ha	Apply only if leafrollers are easy to find.
	• Success 480 SC or Entrust 80 W	145–182 mL/ha 80–109 g/ha	
	• Dipel 2X DF	525–1,125 g/ha	
One month after planting and again once or twice at 2 week intervals			
Common leaf spot	• Copper 53 W	3.8 kg/ha	To control common leaf spot, protect new leaves as they unfold. Spray susceptible varieties such as Jewel, Mira, Kent, Veestar, MicMac. **Copper:** Spray copper alone. For instructions on mixing copper sprays, see *Use of Copper Products on Fruit Crops*, page 269.
	• Supra Captan 80 WDG or Maestro 80 DF	4.25 kg/ha 4.25 kg/ha	
	• Topas or Jade or Mission 418 EC	500 mL/ha 500 mL/ha 300 mL/ha	
	• Pristine WG	1.3–1.6 kg/ha	
July to mid-August			
Potato leafhopper	• Malathion 25 W	2.75–4.25 kg/ha	Potato leafhoppers migrate long distances and can be especially problematic after nearby hay fields are mowed. Check underside of leaves and spray when nymphs are present. Repeated applications may be necessary. **Surround WP:** Apply at 7–14 day intervals when leafhoppers are first detected by monitoring. Use 12.5–25 kg/per 500 L of water. For early applications, use 25 kg/ha. Once a base coat is established, use 12.5 kg per 500 L of water per ha for subsequent sprays. Do not apply during bloom or when fruit is present. Surround may leave a white residue on fruit. See notes on *Kaolin Clay (Surround WP)*, page 247.
	• Assail 70 WP	56–86 g/ha	
	• Surround WP	25 kg/ha	

Diseases and Insects	Products	Rate	Comments
Powdery mildew	• Nova 40 W • Pristine WG • Quintec • Actinovate SP	340 g/ha 1.6 kg/ha 300–440 mL/ha 425 g/ha	Begin applications on susceptible varieties (Annapolis, Jewel, Veestar) when red leaf speckling first appears or when conditions (warm humid weather, or frequent dews) favour development. **Quintec, Pristine, Nova:** For resistance management, make no more than two applications of any product, then rotate to another fungicide group. See *Resistance management strategies by fungicide group and disease for Ontario fruit crops*, page 254. **Actinovate:** Provides suppression rather than control; see Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. Spray to wet foliage but avoid runoff. See *Biopesticides for Disease Control*, page 242 and notes on *Streptomyces lydicus (Actinovate)*, page 242.
Common leaf spot	If leaf spot is present, continue fungicide applications at regular intervals, prior to wetting periods, as outlined above for **One month after planting**. Alternate products from different groups.		
Mid-August and again once or twice at 2-week intervals			
Powdery mildew	Use one of the products listed under **July to mid-August.**		
Common leaf spot	• Copper 53 W • Supra Captan 80 WDG or Maestro 80 DF • Topas or Jade or Mission 418 EC • Pristine WG	3.8 kg/ha 4.25 kg/ha 4.25 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 1.3–1.6 kg/ha	To control common leaf spot, protect new leaves as they unfold. Spray susceptible varieties such as Jewel, Mira, Kent, Veestar, MicMac. Alternate products from different groups. **Copper:** Spray copper alone. Apply in 1,000 L water/ha. For instructions on mixing copper sprays, see *Use of Copper Products on Fruit Crops*, page 269.
Fall			
Red stele	• Ridomil Gold 480 SL • Aliette WDG	1 L/ha 5.6 kg/ha	This disease is sporadic and favoured by wet or compacted soil, and susceptible varieties (Table 5-24. *Strawberry Variety Disease Ratings*, page 135). To reduce the chance of resistance, spray only where red stele has been observed or a high risk situation occurs. **Ridomil Gold:** Make one application in early September and a second treatment in late October, no later than October 31. Apply in sufficient water (2,500 L/ha) to ensure movement into the root zone. **Aliette:** Make up to four applications per season, two in spring and two in fall. Apply as a foliar spray in spring when plants start active growth. Apply at 30–60 day intervals. Make fall applications when soil conditions favour disease development (e.g. high soil moisture, cool temperatures).

June-bearing Strawberry Calendar (fruiting years)

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

Products are listed according to insecticide and fungicide family groups. Use products from different groups to help prevent the development of pest resistance. For resistance management, refer to *Pest Resistance to Insecticides, Fungicides, Miticides*, page 253.

For information on strawberry pest identification, monitoring and thresholds, see *ONTARIO CropIPM: Integrated Pest Management Training*, available at *www.ontario.ca/cropIPM* or as OMAFRA Publication AF141 in CD format.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 5-20. *Products Used on Strawberries*, page 130.

Diseases and Insects	Products	Rate	Comments
When new growth appears			
Strawberry aphid	• Admire 240 F • Assail 70 WP	850 mL–1.3 L/ha 56–86 g/ha	Apply when growth begins in the spring. Do not apply when bloom is present due to bee toxicity. Choose one of the following products; if further aphid control is required choose products in a different insecticide group. **Admire:** Apply as a soil drench in 2,000 L/ha of water as a surface band directly to the plant row. Make this application with sufficient water to ensure incorporation into the root zone. **Assail:** Apply as a foliar spray. Use a 7-day interval between sprays. Use the high rate under heavy pest pressure.
Red stele	• Aliette WDG	5.6 kg/ha	This disease is sporadic and favoured by wet or compacted soil and susceptible varieties (Table 5-24. *Strawberry Variety Disease Ratings*, page 135). To reduce the chance of resistance, spray only where red stele has been observed or a high risk situation occurs. **Aliette:** Make up to four applications per season, two in spring and two in fall. Apply in spring when plants start active growth. Apply at 30–60 day intervals. Do not apply within 30 days of harvest or after first bloom.
Botrytis grey mould	• Bravo 500 or Echo 720	3.5 L/ha 2.4 L/ha	**Bravo, Echo:** Reduces disease inoculum and prevents infection of dying leaves. Repeat application in ten days.
When flower buds are visible in the crown			
Cyclamen mite	• Thionex 50 W or Thionex EC • Agri-Mek 1.9% EC	4.0 kg/ha 5.0 L/ha 1 L/ha	Apply where cyclamen mite has been a problem in the past. These tiny mites feed on developing leaves in the plant crown, causing leaf distortion and stunted growth. **Thionex:** Apply in 4,000–8,000 L of water per ha as a drench over the plant row. **Agri-Mek:** Apply in sufficient water, to ensure thorough leaf coverage. To discourage resistance, alternate Thionex with Agri-Mek.
Common leaf spot	• Copper 53 W • Supra Captan 80 WDG or Maestro 80 DF • Topas or Jade or Mission 418 EC • Pristine WG	3.8 kg/ha 4.25 kg/ha 4.25 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 1.3–1.6 kg/ha	To control leaf spot, protect new leaves as they unfold. Spray susceptible varieties such as Jewel, Mira, Kent, Veestar and MicMac. **Copper:** Spray copper alone. Apply in 1,000 L water/ha. For instructions on mixing copper sprays, see *Use of Copper Products on Fruit Crops*, page 269.

Diseases and Insects	Products	Rate	Comments
As flower buds extend from crown			
Strawberry clipper weevil	• Furadan 480 F	1.1 L/ha	Check edges of fields for clipped buds. See OMAFRA Factsheet *Strawberry Clipper Weevil: A Major Pest of Strawberries*, Order No. 99-031 for monitoring details and thresholds. Apply insecticide when first injury is detected, or wait until threshold is reached. Spray again if new injury is detected seven days after the first spray. **Furadan:** Registration will be withdrawn in 2013. Do not use after December 31, 2012. Do not use later than prebloom because of toxicity to pollinating and beneficial insects. Furadan can cause extensive burning of sepals surrounding fruit on certain varieties (e.g. Annapolis, and Cavendish). Do not use on crops destined for export to the USA.
	• Ripcord 400 EC	175 mL/ha	
	or Up-Cyde 2.5 EC	280 mL /ha	
	• Matador 120 EC	104 mL/ha	
	or Silencer 120 EC	104 mL/ha	
First bloom			
INSECTICIDES ARE VERY TOXIC TO BEES. DO NOT SPRAY WHEN BEES ARE WORKING. SPRAY IN THE EVENING. SEE *BEE POISONING* ON PAGE 267.			
Tarnished plant bugs	• Cygon 480-AG	2.75 L/ha	Do not spray when bees are working. Spray in the evening. See *Bee Poisoning*, page 267. Check frequently during bloom and green fruit stage for small green tarnished plant bug nymphs. Shake blossom clusters and fruit trusses over a shallow dish. Watch for soft-bodied green insects that move quickly to escape. For thresholds and monitoring details, visit *www.ontario.ca/cropipm.* **Cygon:** Very toxic to bees, use before bloom. **Thionex, Ripcord, Up-Cyde, Matador, Silencer, Decis:** These products also control spittlebug. **Ripcord, Up-Cyde, Decis, Matador Silencer (pyrethroid insecticides):** These products, except Decis, also control clipper weevil. Insecticides in this group are associated with outbreaks of spider mites and cyclamen mites. Avoid consecutive applications. **Assail:** Use a 7-day interval between sprays. Use the high rate under heavy pest pressure. Do not apply during bloom due to bee toxicity. **Rimon:** Apply when insects reach economic thresholds but when nymphs are still in the early instar stages. Reapply in 10–14 days. May be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid applying this product to flowering crops or weeds if bees are visiting the treatment area.
	• Ripcord 400 EC	250 mL/ha	
	or Up-Cyde 2.5 EC	400 mL /ha	
	• Decis 5 EC	200 mL/ha	
	• Matador 120 EC	104 mL/ha	
	or Silencer 120 EC	104 mL/ha	
	• Thionex EC	2.5 L/ha	
	• Assail 70 WP	84–210 g/ha	
	• Rimon 10 EC	835 mL/ha	
Botrytis grey mould	• Rovral	2 kg/ha	Ensure good spray coverage to keep all flower parts protected with fungicide during bloom. Typically 2–3 sprays at 7–10 day intervals during bloom will give good control. Use shorter spray intervals (i.e. 5–7 days) during wet weather. Choose fungicides from different chemical groups and use them in rotation. See Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. **Pristine, Lance, Cantus:** These products contain active ingredients in the same fungicide group. Do not alternate Pristine with Lance or Cantus. **Scala, Switch:** Both contain active ingredients in the same fungicide group. Do not alternate Switch with Scala. **Serenade ASO:** Provides suppression rather than control of botrytis grey mould; see Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. Expect best results from multiple applications or when used in rotation with other products. See *Biopesticides for Disease Control*, page 242 and notes on *Bacillus subtilis (Serenade MAX, Serenade ASO)*, page 242. **Actinovate:** Provides suppression rather than control; see Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. Spray to wet foliage but avoid runoff. See *Biopesticides for Disease Control*, page 242 and notes on *Streptomyces lydicus (Actinovate)*, page 242.
	• Elevate 50 WDG	1.7 kg/ha	
	• Supra Captan 80 WDG	4.25 kg/ha	
	or Maestro 80 DF	4.25 kg/ha	
	• Folpan 80 WDG	2.5 kg/ha	
	• Lance WDG	560 g/ha	
	or Cantus WDG	560 g/ha	
	• Pristine WG	1.3–1.6 kg/ha	
	• Scala SC	2 L/ha	
	• Switch 62.5 WG	975 g/ha	
	• Serenade ASO	4–15 L/ha	
	• Actinovate SP	425 g/ha	

Diseases and Insects	Products	Rate	Comments
Anthracnose fruit rot	• Cabrio EG • Pristine WG • Actinovate SP	1 kg/ha 1.3–1.6 kg/ha 425 g/ha	Bloom is the best time to control this disease. Warm wet weather during bloom favours the development of anthracnose fruit rot. **Pristine, Cabrio:** Both contain active ingredients in the same fungicide group. Make no more than two consecutive applications with either product, and then alternate with fungicides from different groups. See Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action,* page 257, and Table 5-21. *Activity of Fungicides on Strawberry Diseases,* page 132. **Actinovate:** May reduce symptoms of anthracnose fruit rot but does not provide full control. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13. See *Biopesticides for Disease Control,* page 242 and notes on *Streptomyces lydicus (Actinovate),* page 242.
7 to 10 days after first bloom			
Botrytis grey mould	Use one of the fungicides listed at **Bloom.**		
Anthracnose fruit rot	Use one of the fungicides listed at **Bloom.**		
Tarnished plant bugs	• Ripcord 400 EC or Up-Cyde 2.5 EC • Decis 5 EC • Matador 120 EC or Silencer 120 EC • Thionex EC • Assail 70 WP • Rimon 10EC	250 mL/ha 400 mL/ha 200 mL/ha 104 mL/ha 104 mL/ha 2.5 L/ha 84–210 g/ha 835 mL/ha	Do not spray when bees are working. Spray in the evening. See *Bee Poisoning* on page 267. Check frequently during bloom and green fruit stage for small green tarnished plant bug nymphs. Shake blossom clusters and fruit trusses over a shallow dish. Watch for soft-bodied green insects that move quickly to escape. For thresholds and monitoring details, visit *www.ontario.ca/cropipm.* **Thionex, Ripcord, Up-Cyde, Matador, Silencer, Decis:** These products also control spittlebug. **Ripcord, Up-Cyde, Decis, Matador, Silencer (pyrethroid insecticides):** These products, except Decis, also control clipper weevil. Insecticides in this group are associated with outbreaks of spider mites and cyclamen mites. Avoid consecutive applications. **Assail:** Use a 7-day interval between sprays. Use the high rate under heavy pest pressure. Do not apply during bloom due to bee toxicity. **Rimon:** Apply when insects reach economic thresholds but when nymphs are still in the early instar stages. Reapply in 10–14 days. May be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid applying this product to flowering crops or weeds if bees are visiting the treatment area.
Thrips	• Delegate WG	280 g/ha	Check blossoms and under calyces for small thread-like yellow thrips. Expect more problems where insecticides have not been applied for tarnished plant bug. Delegate is registered for suppression, rather than control of thrips; see Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13. If populations are high, re-apply in 3-4 days. Delegate is also labelled for greenhouse use.
Green fruit			
Tarnished plant bugs	Continue to monitor for tarnished plant bug. If thresholds are reached, apply one of the products listed at **7 to 10 days after first bloom**. This is the best timing for Rimon and Assail.		
Two-spotted spider mite	• Nexter • Apollo SC • Agri-Mek 1.9% EC • Oberon	600 g/ha 500 mL/ha 1 L/ha 880 mL/ha	Use high water volumes to ensure good coverage of the underside of leaves. To discourage resistance, alternate products from year to year and do not apply any product more than once each year. See Table 5-22. *Miticides Registered on Strawberries,* page 133, for details on timing. **Apollo:** Kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are developing, mostly in the egg stage. **Agri-Mek:** Apply in sufficient water to ensure thorough leaf coverage. **Oberon:** This product is translaminar but not systemic. Good spray coverage of both upper and lower leaf surfaces is needed for control. Use adequate water volume for complete coverage.

Diseases and Insects	Products	Rate	Comments
Preharvest			
Botrytis grey mould	If sprinkler irrigation is used, water early in the day to allow plants to dry off before nightfall. Use one of the fungicides listed at **Bloom.**		
Anthracnose fruit rot	Warm wet weather favours development of anthracnose. In these conditions, use one of the fungicides listed at **Bloom.**		
Spotted wing drosophila	Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into strawberry fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Frequent picking, burial of grade-out fruit, and general sanitation are very important to prevent problems with SWD. Check the OMAFRA website for updates on pest development, registered products and management strategies for control.		
Slugs	• Sluggo Professional	25 kg/ha	Apply 50 kg/ha if population is very high. Apply when infestation begins. Reapply as bait is consumed or at least every two weeks if slugs and snails continue to be a problem.
Thrips	• Delegate WG	280 g/ha	Check blossoms and under calyces for small thread-like yellow thrips. Expect more problems where insecticides have not been applied for tarnished plant bug. Delegate is registered for suppression, rather than control of thrips; see Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13. If populations are high, re-apply in 3-4 days. Delegate is also labelled for greenhouse use.
Renovation (after mowing to July)			
Cyclamen mite	• Thionex 50 W or Thionex EC	4 kg/ha 5 L /ha	These tiny mites feed on developing leaves in the plant crown, causing leaf distortion and stunted growth. High water volumes are needed to wet the new growth in the crown. Apply one of these chemicals in 5,000–8,000 L of water per ha as a drench over the plant row.
New growth after renovation (late July to early August)			
Two-spotted spider mite	• Nexter • Agri-Mek 1.9% EC • Apollo SC • Oberon	600 g/ha 1 L/ha 500 mL/ha 880 mL/ha	For best results, use high water volumes to ensure good coverage of the underside of leaves. To discourage resistance, alternate products from year to year and do not apply any product more than once each year. **Apollo:** Kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are beginning to hatch or are mostly in the egg stage. **Agri-Mek:** Apply in sufficient water, minimum 375 L/ha, to ensure thorough leaf coverage. **Oberon:** This product is translaminar but not systemic. Good spray coverage of both upper and lower leaf surfaces is needed for control. Use adequate water volume for complete coverage.
Powdery mildew	• Nova 40 W • Pristine WG • Quintec • Actinovate SP	340 g/ha 1.6 kg/ha 300–440 mL/ha 425 g/ha	Begin applications on susceptible varieties (Annapolis, Jewel, Veestar) when disease first appears on new growth or when conditions (warm humid weather, or frequent dews) favour development. **Nova, Pristine, Quintec:** For resistance management, make no more than two applications of any product, then rotate to another fungicide group. See *Resistance management strategies by fungicide group and disease for Ontario fruit crops,* page 254. **Quintec:** Apply when conditions favour disease or before the first signs of mildew on foliage. **Actinovate:** Provides suppression rather than control; see Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13. Spray to wet foliage but avoid runoff. See *Biopesticides for Disease Control,* page 242 and notes on *Streptomyces lydicus (Actinovate),* page 242.

Diseases and Insects	Products	Rate	Comments
Mid-August and again once or twice at 2-week intervals			
Powdery mildew	Continue with protectant fungicide applications as outlined above **New growth after renovation.**		
Common leaf spot	• Copper 53 W	3.8 kg/ha	To control leaf spot, ensure good coverage of the lower leaf surface. Spray susceptible varieties such as Jewel, Mira, Kent, Veestar, MicMac. **Copper:** Spray copper alone. For instructions on mixing copper sprays, see *Use of Copper Products on Fruit Crops*, page 269. **Topas, Mission, Jade:** Use a maximum of two applications per season.
	• Supra Captan 80 WDG	4.25 kg/ha	
	or Maestro 80 DF	4.25 kg/ha	
	• Topas	500 mL/ha	
	or Jade	500 mL/ha	
	or Mission 418 EC	300 mL/ha	
	• Pristine WG	1.3–1.6 kg/ha	
Fall			
Botrytis grey mould	• Bravo 500	3.5 L/ha	**Bravo, Echo** helps control *Botrytis* by reducing disease inoculum. Apply in late October.
	or Echo 720	2.4 L/ha	
Red stele	• Ridomil Gold 480 SL	1 L/ha	This disease is sporadic and favoured by wet or compacted soil, and susceptible varieties (Table 5-24. *Strawberry Variety Disease Ratings*, page 135). To reduce the chance of resistance, spray only where red stele has been observed or a high risk situation occurs. **Ridomil:** Do not apply later than October 31. Do not apply in the spring before harvest. Apply in sufficient water (2,500 L/ha) to ensure movement into the root zone. **Aliette:** Make up to four applications per season, two in spring and two in fall. Apply in spring when plants start active growth. Apply at 30–60 day intervals. Do not apply within 30 days of harvest (after first bloom). Make postharvest applications when soil conditions favour disease development (e.g. high soil moisture and cool soil temperatures).
	• Aliette WDG	5.6 kg/ha	

Day-neutral Strawberry Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

Products are listed according to insecticide and fungicide family groups. Use products from different groups to help prevent pest resistance. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253.

For information on strawberry pest identification, monitoring and thresholds, see *ONTARIO CropIPM: Integrated Pest Management Training,* available at *www.ontario.ca/cropIPM* or as OMAFRA Publication AF141 in CD format.

For re-entry period, maximum number of applications and chemical group, see Table 5-20. *Products Used on Strawberries,* page 130.

Diseases and Insects	Products	Rate	Comments
New growth (early spring)			
Aphids	• Admire 240 F • Assail 70WP	850 mL–1.2 L/ha 56–86 g/ha	Apply when growth begins in the spring. Do not apply when bloom is present due to bee toxicity. Choose one of the following products; if further aphid control is required choose products in a different insecticide group. **Admire:** Apply as a soil drench in 2,000 L/ha of water as a surface band directly to the plant row. Make this application with sufficient water to ensure incorporation into the root zone. **Assail:** Apply as a foliar spray. Use a 7-day interval between sprays. Use the high rate under heavy pest pressure.
When flower buds are visible in the crown – late April early May (established plantings planted previous year)			
Strawberry clipper weevil	• Ripcord 400 EC or Up-Cyde 2.5 EC • Matador 120 EC or Silencer 120 EC	175 mL/ha 280 mL /ha 104 mL/ha 104 mL/ha	Strawberry clipper weevil is rarely a problem in first year plantings. Check for clipped buds in overwintered plantings, especially near woods and bush, and especially under floating row covers. Apply an insecticide when the threshold is reached. For thresholds and monitoring details, see *www.ontario.ca/cropipm*.
Two-spotted spider mite	• Apollo SC • Agri-Mek 1.9 % EC • Oberon	500 mL/ha 1 L/ha 880 mL/ha	Occasionally two-spotted spider mites are a problem early in the season, especially where row covers are used. Overwintering TSSM are bright orange. Do not spray for this stage. Wait for this generation to lay eggs. Good spray coverage of both upper and lower leaf surfaces is needed for control. Use adequate water volume for complete coverage. **Apollo:** Spray when mites are mostly in the egg stage. **Agri-Mek:** Spray when mite nymphs are active and there are 15–20 mites per leaf. **Oberon:** This product is translaminar but not systemic.

Diseases and Insects	Products	Rate	Comments
Bloom			
INSECTICIDES ARE VERY TOXIC TO BEES. DO NOT SPRAY WHEN BEES ARE WORKING. SPRAY IN THE EVENING. SEE *BEE POISONING* ON PAGE 267.			
Tarnished plant bugs	• Ripcord 400 EC	250 mL/ha	Do not spray when bees are working. Spray in the evening. See *Bee Poisoning*, page 267. **In established plantings that were overwintered,** check for tarnished plant bugs as soon as row covers are removed (early May) and continue at weekly intervals when bloom and green fruit are present. **In new plantings**, remove blossom clusters until plants are well established (6–8 new leaves). Subsequent bloom in new plantings typically coincides with the second generation of tarnished plant bug (**early July**). Pressure is high at this time and damage can occur quickly. **In all plantings:** Shake blossom clusters and fruit trusses over a shallow dish. Watch for soft-bodied green insects that move quickly to escape. For thresholds and monitoring details, see *www.ontario.ca/cropipm*. Check the days to harvest intervals before spraying. Rimon and Assail have short preharvest intervals and can be used during harvest. In order to meet restrictions limiting the number of applications, most growers will reserve the use of Rimon and Assail until closer to harvest. **Ripcord , Up-Cyde, Decis, Matador, Silencer (pyrethroid insecticides):** These products, except Decis, also control clipper weevil. Insecticides in this group are associated with outbreaks of spider mites, thrips and cyclamen mites. Avoid consecutive applications. **Assail:** Use a 7-day interval between sprays. Works best on small nymphs in early instars. Use the high rate under heavy pest pressure and older nymphs (3–5th instar) . Do not apply during bloom due to bee toxicity. **Rimon:** Apply when insects reach economic thresholds but when nymphs are still in the early instar stages. Reapply in 10–14 days. May be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid applying this product to flowering crops or weeds if bees are visiting the treatment area.
	or Up-Cyde 2.5 EC	400 mL/ha	
	• Decis 5 EC	200 mL/ha	
	• Matador 120 EC	104 mL/ha	
	or Silencer 120 EC	104 mL/ha	
	• Thionex EC	2.5 L/ha	
	• Assail 70 WP	84–210 g/ha	
	• Rimon 10 EC	835 mL/ha	
Botrytis grey mould	• Rovral	2 kg/ha	Ensure good spray coverage to keep all flower parts protected with fungicide during bloom. Typically 7–10 day intervals during bloom will give good control. Use shorter spray intervals (i.e. 5–7 days) during wet weather. Choose fungicides from different chemical groups and use them in rotation. See Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. **Pristine, Lance, Cantus:** These products contain active ingredients in the same fungicide group. Do not alternate Pristine with Lance or Cantus. **Scala, Switch:** Both contain active ingredients in the same fungicide group. Do not alternate Switch with Scala. **Serenade ASO:** Provides suppression rather than control of botrytis grey mould; see Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. Expect best results from multiple applications or when used in rotation with other products. See *Biopesticides for Disease Control*, page 242 and notes on *Bacillus subtilis (Serenade MAX, Serenade ASO)*, page 242. **Actinovate:** Provides suppression rather than control; see Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. Spray to wet foliage but avoid runoff. See *Biopesticides for Disease Control*, page 242 and notes on *Streptomyces lydicus (Actinovate)*, page 242.
	• Elevate 50 WDG	1.7 kg/ha	
	• Supra Captan 80 WDG	4.25 kg/ha	
	or Maestro 80 DF	4.25 kg/ha	
	• Folpan 80 WDG	2.5 kg/ha	
	• Lance WDG	560 g/ha	
	or Cantus WDG	560 g/ha	
	• Pristine WG	1.3–1.6 kg/ha	
	• Scala SC	2 L/ha	
	• Switch 62.5 WG	975 g/ha	
	• Serenade ASO	4–15 L/ha	
	• Actinovate SP	425 g/ha	

Diseases and Insects	Products	Rate	Comments
Anthracnose fruit rot	• Cabrio EG • Pristine WG • Actinovate SP	1 kg/ha 1.3–1.6 kg/ha 425 g/ha	Warm wet weather during bloom favours the development of anthracnose fruit rot. **Pristine, Cabrio:** Both contain active ingredients in the same fungicide group. Make no more than two consecutive applications with either product, and then alternate with fungicides from different groups. See Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action,* page 257. **Actinovate:** May reduce symptoms of anthracnose fruit rot but does not provide full control. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13. See *Biopesticides for Disease Control,* page 242 and notes on *Streptomyces lydicus (Actinovate),* page 242. Spray to wet foliage but avoid runoff.
Powdery mildew	• Nova 40 W • Pristine WG • Quintec • Actinovate SP	340 g/ha 1.6 kg/ha 300–440 mL/ha 425 g/ha	Begin applications when red leaf speckling first appears or when conditions (warm humid weather, or frequent dews) favour development. **Nova, Pristine, Quintec:** For resistance management, make no more than two applications of any product, then rotate to another fungicide group. See *Resistance management strategies by fungicide group and disease for Ontario fruit crops,* page 254. **Quintec:** Apply when conditions favour disease or before the first signs of mildew on foliage. **Actinovate:** Provides suppression rather than control; see Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13. Spray to wet foliage but avoid runoff. See *Biopesticides for Disease Control,* page 242 and notes on *Streptomyces lydicus (Actinovate),* page 242.
Green fruit			
Two-spotted spider mite	• Oberon • Nexter • Apollo SC • Agri-Mek 1.9% EC	880 mL/ha 600 g/ha 500 mL/ha 1 L/ha	Use high water volumes to ensure good coverage of the underside of leaves. To discourage resistance, alternate products from year to year and do not apply any product more than once each year. See Table 5-22. *Miticides Registered on Strawberries,* page 133, for details on timing. **Oberon:** This product is translaminar but not systemic. Good spray coverage of both upper and lower leaf surfaces is needed for control. **Nexter:** Most effective on mite nymphs. **Apollo:** Kills mite eggs and very young nymphs, but not older nymphs and adults. This product is most useful early in the season for the first generation of mites. Apply when monitoring indicates mites are developing, mostly in the egg stage. **Agri-Mek:** Apply in sufficient water to ensure thorough leaf coverage.
Tarnished plant bug	Continue to monitor for tarnished plant bug. If thresholds are reached, choose an insecticide listed at **Bloom** for this pest, but check the preharvest interval. Late May and early July are periods of peak activity for tarnished plant bugs, but populations vary due to the use of row covers, crop management, weed species in the field, nearby alfalfa and clover crops, and insecticides applied for other pests. Weekly monitoring is important.		

Diseases and Insects	Products	Rate	Comments
Bloom and green fruit and harvest (June, July, August)			
Spotted wing drosophila	Spotted wing drosophila (SWD) is a new invasive fruit fly that inserts eggs into strawberry fruit as they are ripening. Larvae develop in the fruit and may be present at harvest, contributing to premature breakdown. Populations build up in late summer, putting day-neutral strawberries at risk . Frequent picking, burial of grade-out fruit, and general sanitation are very important to prevent problems with SWD. Check the OMAFRA website for updates on pest development, registered products and management strategies for control.		
Tarnished plant bugs	• Assail 70 WP • Rimon 10 EC	84–210 g/ha 835 mL/ha	Do not spray when bees are working. Spray in the evening. See *Bee Poisoning*, page 267. Shake blossom clusters and fruit trusses over a shallow dish. Watch for soft-bodied green insects that move quickly to escape. For thresholds and monitoring details, see *www.ontario.ca/cropipm*. Check the days to harvest intervals before spraying. Rimon and Assail have short preharvest intervals and can be used during harvest. **Assail:** Use a 7-day interval between sprays. Works best on small nymphs in early instars. Use the high rate under heavy pest pressure and older nymphs (3–5th instar) . Do not apply during bloom due to bee toxicity. **Rimon:** Apply when insects reach economic thresholds but when nymphs are still in the early instar stages. Reapply in 10–14 days. May be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid applying this product to flowering crops or weeds if bees are visiting the treatment area.
Thrips	• Delegate WG	280 g/ha	Check blossoms and under calyces for small thread-like yellow thrips. Expect more problems where insecticides have not been applied for tarnished plant bug. Delegate is registered for suppression, rather than control of thrips; see Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. Delegate is also labelled for greenhouse use.
Two-spotted spider mite	• Oberon	880 mL/ha	Use high water volumes to ensure good coverage of the underside of leaves. To discourage resistance, alternate products from year to year and do not apply any product more than once each year. See Table 5-22. *Miticides Registered on Strawberries*, page 133, for details on timing. **Oberon:** This product is translaminar but not systemic. Good spray coverage of both upper and lower leaf surfaces is needed for control. Use adequate water volume for complete coverage.
Potato leafhopper	• Malathion 25 W	4.25 kg/ha	Check leaf edges for yellowing and check the lower leaf surface for small, rapidly moving bright green nymphs. Potato leafhoppers have many hosts and often build up in strawberry fields after the first few cuts of local hay. Albion is especially susceptible to leafhoppers.
Botrytis grey mould	Use one of the fungicides listed at **Bloom.**		
Anthracnose fruit rot	Use one of the fungicides listed at **Bloom.**		
Powdery mildew	This is an important time for mildew control. Use one of the products listed at **Bloom.**		
Bloom, green fruit and harvest (September)			
Slugs	• Sluggo Professional	25 kg/ha	Apply 50 kg/ha if population is very high. Apply when infestation begins. Reapply as bait is consumed or at least every two weeks if slugs and snails continue to be a problem.
Tarnished plant bug	Continue to monitor for tarnished plant bug. If thresholds are reached in early September, choose an insecticide listed at **Bloom and green fruit and harvest (June, July, August)** for this pest.		
Powdery mildew	This is an important time for mildew control. Use one of the products listed under **Bloom.**		
Botrytis grey mould	Use one of the fungicides listed at **Bloom.**		

Table 5-20. Products Used on Strawberries

Use this as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects and mites.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used to control or suppress insects and mites						
Admire 240 F	24094	imidacloprid	4	30 days	24 hours	1
Agri-Mek 1.9% EC	24551	abamectin	6	3 days		2
Assail 70 WP	27128	acetamiprid	4	1 day	12 hours	2
Apollo SC	21035	clofentezine	10	15 days	12 hours	1
Cygon 480-AG	25651	dimethoate	1B	7 days		2
Dipel 2X DF	26508	*Bacillus thuringiensis*	11	1 day		
Decis 5 EC	22478	deltamethrin	3	14 days		2
Delegate WG	28778	spinetoram	5	1 day	12 hours	3
Entrust 80 W	27825	spinosad	5	3 days		3
Furadan 480 F **	10828	carbofuran	1A	Use prebloom only	48 hours	1
Malathion 25 W	14656	malathion	1B	3 days		
Matador 120 EC	24984	lambda-cyhalothrin	3	7 days	24 hours	3
Nexter	25135	pyridaben	21	10 days	24 hours	2
Oberon	28905	spiromesifin	23	3 days	12 hours	3
Rimon 10 EC	28881	novaluron	15	1 day	12 hours	3
Ripcord 400 EC	15738	cypermethrin	3	7 days		3
Silencer 120 EC	29052	lambda-cyhalothrin	3	7 days	24 hours	3
Sluggo Professional	30025	ferric phosphate				
Success 480 SC	26835	spinosad	5	3 days		3
Surround WP	27469	kaolin		1 day		
Thionex EC	23453	endosulfan	2A	7 days	7 days/4 days[1]	2
Thionex 50 W	14617	endosulfan	2A	12 days	12 days/ 7 days[1]	2
Up-Cyde 2.5 EC	28795	cypermethrin	3	7 days	12 hours	3

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period is as follows: re-entry/scouting, weeding, irrigation, mulching.

[2] Re-entry period is as follows: re-entry/hand labour, e.g., training, pinching, pruning, harvest.

** Registration will be withdrawn in 2013. Do not use after December 31, 2012.

Table 5-20. Products Used on Strawberries (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used to control or suppress diseases						
Actinovate SP	28672	*Streptomyces lydicus*	NC		1 hour	
Aliette WDG	24458	fosetyl al	U	30 days		4
Bravo 500	15723	chlorothalonil	M	30 days	48 hours	3
Cabrio EG	27323	pyraclostrobin	11	1 day	12 hours	5
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Copper 53 W	9934	tri-basic copper sulphate	M	1 day	48 hours	5
Echo 720	29355	chlorothalonil	M	30 days	48 hours	3
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Folpan 80 WDG	27733	folpet	M	1 day	24 hours	6
Jade	24030	propiconazole	3	1 day	72 hours	4
Lance WDG	27495	boscalid	7	0 days	12 hours	5
Maestro 80 DF	26408	captan	M	2 days	48 hours	
Mission 418 EC	28016	propiconazole	3	1 day	72 hours	4
Nova 40 W	22399	myclobutanil	3	3 days		6
Pristine WG	27985	boscalid + pyraclostrobin	7+11	1 day	When dry/ 24 hours[2]	5
Quintec	29755	quinoxyfen	13	1 day	12 hours	4
Ridomil Gold 480 SL	28474	metalaxyl-M and S	4	Use post-harvest only	12 hours	2
Rovral	15213	iprodione	2	1 day	12 hours	
Scala SC	28011	pyrimethanil	9	1 day	12 hours	3
Serenade ASO	28626	*Bacillus subtilis*	44	0 days		
Supra Captan 80 WDG	24613	captan	M	2 days	48 hours	
Switch 62.5 WG	28189	cyprodinil + fludioxonil	9+12	1 day	12 hours	3
Topas	30163	propiconazole	3	1 day	72 hours	4

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period is as follows: re-entry/scouting, weeding, irrigation, mulching.

[2] Re-entry period is as follows: re-entry/hand labour, e.g., training, pinching, pruning, harvest.

** Registration will be withdrawn in 2013. Do not use after December 31, 2012.

Notes on strawberry diseases and insects

For information on strawberry pest identification, monitoring and thresholds, see *ONTARIO CropIPM: Integrated Pest Management Training*, available at *www.ontario.ca/cropIPM* or as OMAFRA Publication AF141 in CD format.

For information on the activity of fungicides on strawberry diseases, see Table 5-21. *Activity of Fungicides on Strawberry Diseases*, on this page. For information on miticides registered on strawberries, see Table 5-22. *Miticides Registered on Strawberries*, page 133. For information on the activity of insecticides on strawberry pests, see Table 5-23. *Activity of Insecticides on Strawberry Pests and Bees*, page 134. For information on the response of different strawberry varieties to diseases, see Table 5-24. *Strawberry Variety Disease Ratings*, page 135.

Table 5-21. Activity of Fungicides on Strawberry Diseases

Ratings in shaded boxes indicate that the disease is listed on the product label for control or suppression. Please see the product label or crop calendars for registered uses. Use fungicides only for diseases listed on the product label for the crop and for the disease. Additional information is provided in this table to assist the grower in choosing the best fungicide for control of diseases listed on the product label. Where ratings are not in shaded cells, some activity against this disease is anticipated, but this use is not on the product label. Consult the label for more information. The information provided in this table is intended to assist the grower in choosing the best fungicide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Fungicide Group	Product	Angular leaf spot	Anthracnose (*C. acutatum*)	Anthracnose (*C. gloeosporioides*)	Botrytis grey mould	Common leaf spot	Leather rot	Leaf scorch	Phomopsis leaf blight and fruit rot	Phytophthora crown rot	Powdery mildew	Red stele root rot
M	Copper 53 W	++P	+P	+P	+P	+P	+P	+P	+P	0	+P	0
M	Captan 80 WDG	0	++	++	++	+++	+	+	+ to ++	0	0	0
M	Folpan 80 WDG	0	++	++	++	+++	+		+ to ++	0	0	0
M	Maestro 80 DF	0	++	++	++	+++	+		+ to ++	0	0	0
M	Bravo 500	0			++	+		+	+	0		0
M	Echo 720	0			++	+		+	+	0		0
2	Rovral	0	0	0	+++R	++	0		0	0	0	0
3	Jade	0	0	0	0	+++	0		+++	0	+++	0
3	Nova 40 W	0	0	0	0	++	0		+++	0	+++	0
3	Mission 418 EC	0	0	0	0	+++	0		+++	0	+++	0
3	Topas	0	0	0	0	+++	0		+++	0	+++	0
4	Ridomil Gold SL	0	0	0	0	0	++	0	0	++ to +++	0	++ to +++
7	Cantus WDG	0			+++	+++	0	+++	0	0	++	0
7	Lance WDG	0			+++	+++	0	+++	0	0	++	0
7&11	Pristine WG	0	+++	+++	+++	+++	0	+++	+++	0	+++	0
9	Scala SC	0	+		+++		0			0		0
9&12	Switch 62.5 WG		++		+++		0	++	++	0	+	
11	Cabrio EG	0	+++	+++	+ to ++	+	0	++	+++	0	+++	0
13	Quintec	0	0	0	0	0	0	0	0	0	+++	0
17	Elevate 50 WDG	0	0	0	+++		0	0	0	0	0	0
44	Serenade ASO				+							
NC	Actinovate		+	+	+						+	
U	Aliette WDG	0	0	0	0	0	++	0	0	++	0	++

0 = No control; + = Poor to fair control; ++ = Good control, some limitations; +++ = Excellent control, few if any limitations.
Blank cell = Information is unavailable.
P = May be phytotoxic.
R = Pathogen resistance to the fungicide has occurred in some locations outside Ontario.

Table 5-22. Miticides Registered on Strawberries

	Mite species controlled	Stage of mite controlled	Comments	Preharvest interval
Apollo SC	Two-spotted spider mite	Eggs, very young nymphs	Apply when most mites are in the egg stage. This miticide works best if applied early in the season, when generations tend to be most synchronous.	15 days
Agri-Mek 1.9% EC	Two-spotted spider mite, cyclamen mite	Adults, nymphs	Translaminar (locally systemic). Absorbed best by new, expanding leaves. Registered for both cyclamen mite and two-spotted spider mite. Do not use with surfactants or oil.	3 days
Nexter	Two-spotted spider mite	Adults, nymphs	A contact miticide providing rapid knockdown of adults and nymphs.	10 days
Oberon	Two-spotted spider mite	Eggs, adults, nymphs	A slow acting miticide which prevents eggs from hatching and nymphs from moulting to the next stage. Best used when mites are young.	3 days

Table 5-23. Activity of Insecticides on Strawberry Pests and Bees

Ratings in shaded cells indicate pests are listed on the product label for control or suppression. Use products only for pests listed on the label for the crop and for the pest. Additional information is provided in this table to assist the grower in choosing the best insecticide or miticide for control of pests listed on the product label. Where ratings are not in shaded cells, some activity against this insect is anticipated, but this use is not on the product label. Consult the label for more information. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Group	Insecticide/ miticide	Aphids	Clipper weevil	Tarnished plant bug	Root weevil larvae	Root weevil adults	Flower thrips	Leaf rollers	Potato leafhopper	Two-spotted spider mite	Cyclamen mite	Spittle bug	Spotted wing drosophila	Honey bees
1A	Furadan 480 F[1]	+	+++	+	+	++	NA	+++	NA	0	0	++	NA	HT
1B	Cygon 480-AG	+++	+	+++	0		NA	+++	++	0	0	++	NA	HT
1B	Malathion 25 W	+	+	++	0	0		++	++	0	0	++	NA	HT
2A	Thionex (various formulations)	+++	+	+++	0	+	+	++	+	0	+++	++		MT
3	Decis 5 EC	0	0	+++	0	0	++	+++	++	0	0	++	+++	HT
3	Ripcord 400 EC	0	+++	+++	0	++	++	+++	++	0	0	++	+++	HT
3	Matador 120 EC	0	+++	+++	0	++	++	+++	++	0	0	++	+++	HT
3	Silencer 120 EC	0	+++	+++	0	++	++	+++	++	0	0	++	+++	HT
3	Up-Cyde 2.5 EC	0	+++	+++	0	++	++	+++	++	0	0	++	+++	HT
4	Admire 240 F	+++	++						+++	0	0			HT
4	Assail 70 WP	+++		++					+++	0	0	++		HT
5	Delegate WG				0		++	++		0	0		+++	HT
5	Entrust 80 W	0			0		++	+++		0	0		+++	HT
5	Success 480 SC	0			0		++	+++		0	0		+++	HT
6	Agri-Mek 1.9% EC	0	0	0	0	0	+	0	+	+++	++		0	HT
10	Apollo SC	0	0	0	0	0	0	0	0	+++	0	0	0	S
11	Dipel 2X DF	0	0	0	0	0	0	++			0	0	0	S
15	Rimon 10 EC			+++				+++		0	0		0	MT[2]
21	Nexter	0	0	0	0	0	0	0	0	+++	++	0	0	HT
23	Oberon	0	0	0	0	0	0	0	0	+++		0	0	S
NC	Surround WP				0		NA		++	++				I

0 = No control; + = Poor to fair control; ++ = Good control, some limitations; +++ = Excellent control, few if any limitations; NA= Not used at the timing for this pest.
Blank cell = Information is unavailable.
R – Pest resistance has occurred in some crops.
Bee toxicity: HT= highly toxic; MT= moderately toxic; S = relatively safe or non-toxic; I = irritant.

[1] Do not use Furadan after December 31, 2012. Registration will be withdrawn in 2013.

[2] Rimon may be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid spraying if bees are visiting the treatment area.

Table 5-24. Strawberry Variety Disease Ratings

	Leaf spot*	Leaf scorch[1]	Powdery mildew	Botrytis grey mould	Verticillium	Red stele[2]*	Bacterial angular leaf spot[3]	Black root rot	Anthracnose fruit rot
Albion	MR		MR	S	R				MR
Allstar	MR	I	MR	MR	MR	S	HS	S	
Annapolis	MR	MR	S	S	MR	R	HS		S
Brunswick	MR	MR	MR	MR		R		MR	
Cabot	MR	MR	R	S	S	R		MR	
Cavendish	MR	R	S	MR	MR	R	HS	MR	S
Evangeline	MR	R	MR	MR	S	S		S	
Glooscap	MR	MR	MR	S	S	S	S		
Gov. Simcoe	MR	MR	HS	S	MR	S	S		S
Honeoye	MR	MR	MR	MR	HS	S	HS	S	
Jewel	MR	MR	S	MR	S	S	HS	HS	
Kent	HS	HS	MR	S	S	S	HS	HS	S
L'Amour			S	MR		MR	S	MR	
Micmac	S	HS	MR	S	MR	S	S		
Mira	HS	R	R	MR	S	R	S	S	
Mohawk	MR	MR	MR	MR	MR	MR			
Sable	R	R	S	S		R	HS		
St. Pierre	MR	S	MR	R		S			S
Sapphire		MR	MR						
Seascape	S		HS						
Serenity		MR	MR						S
Sparkle	S	MR	MR	MR	S	HR	S		
Summer Dawn (V151)	S	S							HS
Summer Rose (R14)									S
Summer Ruby (2V55)									S
Summer Evening (108Y79)									S
Tribute	MR	MR	S	MR	R	MR			
Tristar	MR	MR	S	MR	R	MR	MR		
Valley Sunset				S			S		
Veestar	S	MR	S	MR	MR	HS	S		
Wendy	S	MR	MR	MR	S	MR	HS	S	

HR – Highly Resistant; R – Resistant; MR – Moderately Resistant; S – Susceptible; HS – Highly Susceptible.
Blank cell = Information is unavailable.
* Race dependent.
[1] Leaf scorch ratings according to Xue, Sutton, Dale, and Sullivan 1996, for some cultivars.
[2] Red stele ratings from Dr. N. Nickerson and Dr. A. Jamieson, Agriculture & Agri-Food Canada, Kentville, Nova Scotia.
[3] P.D. Hildebrand, P.G. Braun et. al., Can. J. Plant.Pathol.27:16-24 (2005) and field observation.

6. Grapes

Grape Nutrition

Test the soil a year in advance of planting grape vines, or two years before planting where pH adjustment may be necessary. Some soil amendments do not move readily through the soil profile, but are needed to optimize vineyard productivity. These materials include organic matter, phosphorus, potassium, and lime to adjust soil pH. The only opportunity to thoroughly incorporate these materials is before planting.

Manure for Vineyards

Manure can pose a food safety risk on many fruit crops. Ensure at least 120 days between manure application and harvest.

Manure contains beneficial organic matter and provides many macro and micronutrients. The organic nitrogen in manure is mineralized over time, providing nitrogen in diminishing quantities for several years after application. When manure is used, adjust applied inorganic nitrogen to avoid over applications. Excessive nitrogen, particularly in the second half of the growing season, can result in poor fruit colour, excessive growth and delayed hardening of the woody tissue, which may make plants more susceptible to winter injury. Observe the following guidelines to receive the benefits of manure while minimizing potential problems:

- Apply no more than 7 tonnes/ha of poultry manure (20 m^3 liquid), 40 tonnes/ha of cattle manure (100 m^3 liquid) and 35 tonnes/ha of hog manure (65 m^3 liquid). Since the nutrient content of manure varies considerably, it should be tested before application. See *Manure nitrogen,* page 22.

- Broadcast manure and work it into the soil in late fall or early spring before planting.

- Do not place manure around newly planted vines in late summer as winter injury may result.

- Adjust the rate of nitrogen, phosphorus and potassium fertilizers applied according to the nutrient content of the manure. See Table 3-11. *Average Fertilizer Replacement Values for Different Types of Manure,* page 22.

- For more information about food safety and the environmental impacts of manure application, see *Manure nitrogen* and *Use manure responsibly,* page 22.

pH Requirements

The pH of a soil is a measure of its acidity and affects nutrient uptake and crop performance. If the soil test report recommends a lime application to increase soil pH, add lime at recommended rates prior to planting. For details regarding rates and suggested types of lime to use, refer to *Soil pH and Liming,* page 18.

In established vineyards sample soil in the vine row every three years to ensure the pH is satisfactory. If pH is low or acidic, apply lime in the fall to the sod cover or before spring cultivation. The results will not show immediately because lime reacts slowly in the soil. Apply lime to established vineyards when the pH drops below 5.1 on clay loam soils or 5.6 on sandy soils. Lime raises the soil pH, reduces its acidity and also supplies calcium. For details regarding rates and suggested types of lime to use, refer to *Soil pH and Liming,* page 18.

Petiole Analysis

In established plantings, the best way to determine the nutrient status of the vines is by petiole analysis. In conjunction with soil analysis, it provides good information for adjusting fertilizer rates. For more information on these tests, see *Plant tissue analysis,* page 16.

Nutrient uptake is affected by many vineyard conditions and varies slightly from year to year, depending on the season. To obtain optimum growth and fruit quality, all nutrients must be present in sufficient concentrations. See Table 6-1. *Nutrient Sufficiency Range of Grape Petioles,* page 138.

For petiole analysis to be most useful, sample the same vines each year. Use these tests along with soil testing to determine the fertilizer program. Soil management practices, vine age, rootstock, soil type, previous fertilizer program, growth, and quality must also be considered to determine fertilizer requirements.

Table 6-1. Nutrient Sufficiency Range of Grape Petioles (Taken in September from Mature Vines)

Variety	N	P	K*	Ca	Mg	Fe	B	Zn	Mn
	%					ppm			
Vinifera	0.8–1.4	0.15–0.4	1.2–2.3	1–3	0.6–1.5	15–100	20–60	15–100	20–200
Labrusca (Fredonia)	0.6–1.2	0.15–0.4	0.8–1.8	1–3	0.6–1.5	15–100	20–60	15–100	20–200
Other	0.7–1.3	0.15–0.4	1–2	1–3	0.6–1.5	15–100	20–60	15–100	20–200

* Potassium levels may be higher in grapes grown on sandy loam soils.

Fertilizer for Grapes

The best time to effectively incorporate nutrients such as potassium, phosphorus, boron and lime into the soil is prior to planting the vineyard. Nutrient levels in the topsoil adequate for vineyard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium and 1,000–5,000 ppm calcium. Table 6-2. *Phosphorus and Potassium Soil Requirements for New Plantings of Grapes,* on this page, provides fertilizer rates prior to planting. Along with incorporation of organic matter such as manure, these fertility levels will sustain the vineyard through the juvenile years.

- High nitrogen levels can result in excessive growth and incomplete vine hardening. Use cover crops to reduce late season nitrogen levels in cultivated vineyards, especially in new plantings. Sow cover crops such as Italian ryegrass about July 1 to take up much of the available nitrogen in the soil.

Nitrogen (N)

Use petiole analysis to determine nitrogen requirements. Use 34 kg of nitrogen per ha only if this information is not available. Broadcast nitrogen before the first cultivation. In vineyards with sod between the rows, apply nitrogen as early as possible in the spring. Where urea (46-0-0) is applied, it must be incorporated to reduce losses by volatization. Do not use urea in vineyards with sod between the rows because incorporation is not possible. Reduce rates or eliminate nitrogen entirely if manure is used or growth has been excessive. If severe winter temperatures cause fruit bud damage, it may be necessary to split nitrogen applications. Apply the first application in early May, and the second application, if necessary, after bloom in late June. During dry springs, use irrigation to move the fertilizer into the rooting zone just before first bloom or immediately after capfall. Consider foliar applications of nitrogen if vine performance and petiole analysis suggest the need.

Phosphorus (P)

Grapes do not require high levels of soil phosphorus. With a few exceptions, the level of phosphorus in Ontario soils is adequate for grapes. Use a soil test to determine if phosphorus fertilizer is required. A phosphorus soil test value between 12–20 ppm is adequate for vineyard establishment and production. When establishing a new planting, apply phosphorus before planting and thoroughly incorporate it into the soil. See Table 6-2. *Phosphorus and Potassium Soil Requirements for New Plantings of Grapes,* on this page. In established plantings, use petiole analysis along with soil analysis to estimate phosphorus requirements. Additional phosphorus may be needed for sod or cover crop maintenance.

Table 6-2. Phosphorus and Potassium Soil Requirements for New Plantings of Grapes

Soil phosphorus		Soil potassium *	
Soil test (ppm P)	Phosphate (P_2O_5) required (kg/ha)	Soil test (ppm K)	Potash (K_2O) required (kg/ha)
0–3	80 HR	0–15	270 HR
4–5	60 HR	16–30	270 HR
6–7	50 HR	31–45	270 HR
8–9	40 MR	46–60	270 HR
10–12	20 MR	61–80	270 HR
13–15	0 LR	81–100	270 HR
16–20	0 LR	101–120	270 HR
21–25	0 RR	121–150	270 MR
26–30	0 RR	151–180	270 MR
31–40	0 RR	181–210	270 MR
41–50	0 RR	211–250	270 LR
51–60	0 RR	250 +	270 LR
61–80	0 NR		
80 +	0 NR		

* For new plantings, apply only every second year. For established grapes, use plant analysis to estimate requirements of N, P and K.

HR, MR, LR, RR, and NR denote, respectively: high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

Table 6-3. Magnesium Foliar Sprays

Timing	Product	Rate	Notes
3 sprays spaced 10 days apart beginning in mid-July	Magnesium sulfate (Epsom salts)	20 kg/1,000 L water	Wet plant to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

Potassium (K)

Grapes require larger amounts of potassium than tree fruits. In established plantings, use petiole analysis along with soil analysis to estimate potassium to determine requirements. Excess potassium can lead to deficiency of magnesium (Mg). Avoid unnecessary potassium applications.

Prior to establishment, incorporate potassium according to Table 6-2. *Phosphorus and Potassium Soil Requirements for New Plantings of Grapes,* page 138. In established cultivated vineyards, broadcast potassium before the first cultivation in the spring. In established vineyards with sod between the rows, and in vineyards on clay soils, apply potassium in a band to reduce potassium fixation and increase its availability to the vines. Muriate of potash (0-0-60, potassium chloride) can injure roots and trunks if applied too closely to the trunk.

Foliar application of potassium for grapes

In dry growing seasons, potassium is not readily available to the plant. When a potassium deficiency occurs, foliar applications of potassium may help. Foliar potassium applied at veraison (when grapes begin to ripen) may improve fruit yield and quality.

Magnesium (Mg)

Magnesium soil test values between 100–250 ppm are adequate for grapes. Dolomitic limestone can be used on acidic soils to raise the soil pH and to supply magnesium. Magnesium deficiency has become more evident in vineyards, particularly when high rates of potassium are used.

Magnesium deficiency can lead to premature fruit drop. Because magnesium is a part of the chlorophyll molecule, magnesium deficient vines have older leaves that are pale in colour. Petiole analysis is the best way to evaluate magnesium levels.

Foliar sprays correct magnesium deficiency for the current year only. For long-term corrections, apply magnesium to the soil in early spring. On some soil types a single, early-spring application of soil-applied magnesium may not be enough. A second or third application the next spring may be required before the magnesium level in the plant improves.

Foliar sprays are recommended for the first two years, in addition to soil applications. See Table 6-3. *Magnesium Foliar Sprays,* on this page.

Fruit or foliage injury may occur if pesticides are mixed with magnesium sulphate (Epsom salts). Pesticides should be applied as a separate spray. Check the manufacturer's label about mixtures of magnesium chelates with pesticides. Use only chelates recommended for foliar sprays.

Calcium (Ca)

Calcium deficiency has been associated with strachis (cluster stem) breakdown of Canada Muscat and Himrod grapes. This deficiency is usually associated with water uptake imbalances in the vine during bloom and immediately post fruit set. It is difficult to correct with calcium foliar sprays.

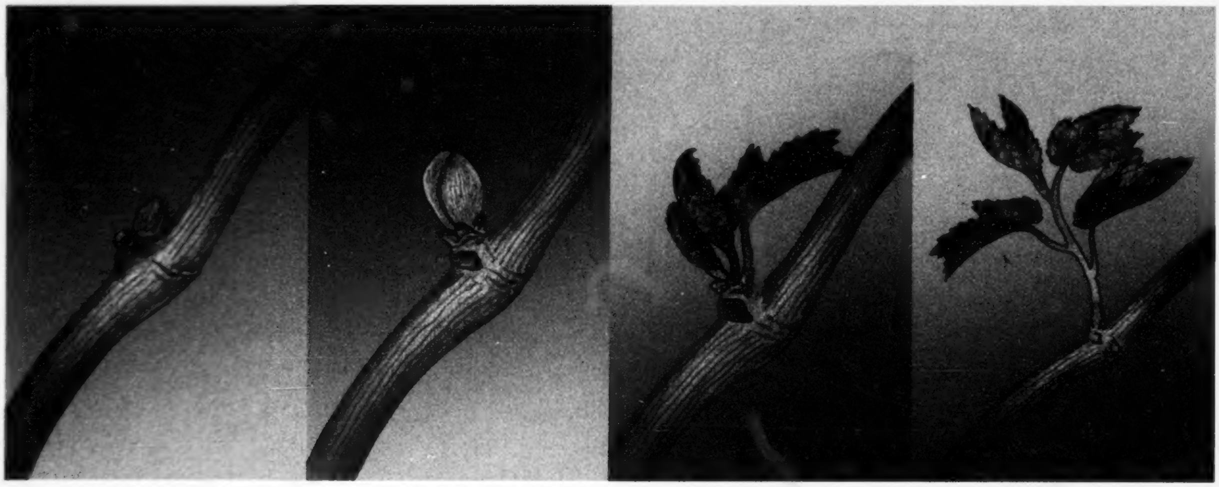
Micronutrients

Deficiencies of micronutrients are not widespread in Ontario plantings. The desirable range for micronutrients is quite narrow. Micronutrients applied in excess can cause more damage than deficiencies. For this reason, do not apply micronutrients unless petiole analysis confirms a deficiency. Apply only the nutrient that is deficient and only in sufficient quantities to correct the problem.

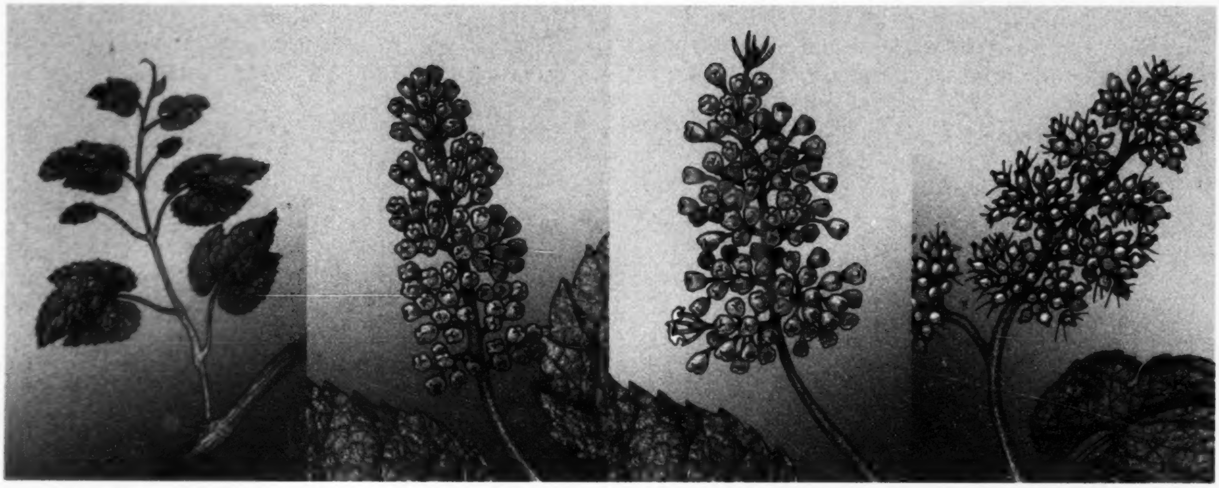
Lime-induced chlorosis is a deficiency in iron or manganese occasionally induced by alkaline soils with high soil bicarbonates or by excessive lime application. For additional information, see *Micronutrients,* page 26.

Apply nutrients according to recommended rates on the product label. Do not spray during temperatures above 25°C.

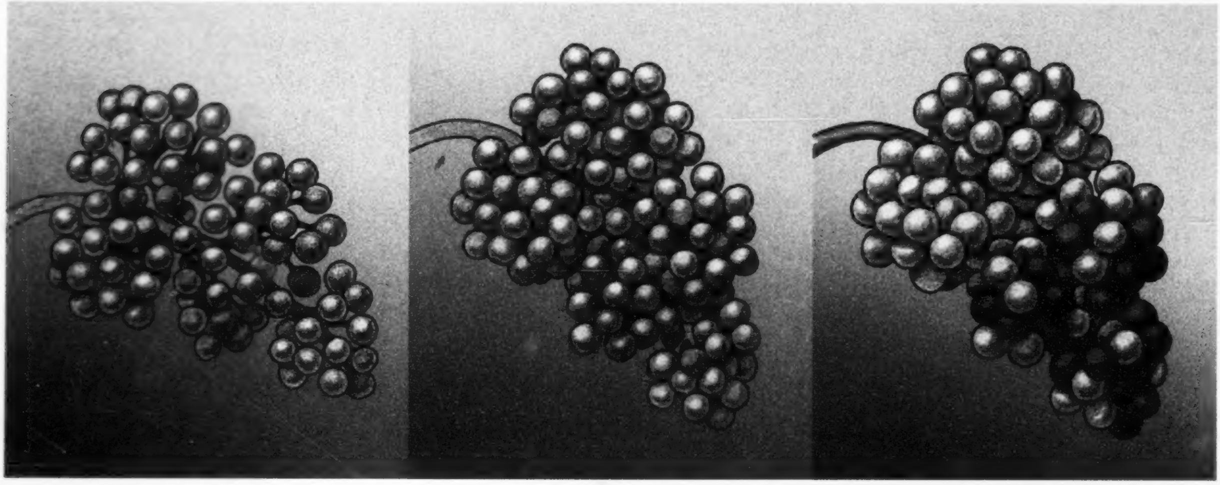
Figure 6-1. Grape Growth Stages



Dormant Bud Burst First Leaf 3–5 Leaves



20–25 cm Shoot Immediate Prebloom Trace Bloom Immediate Postbloom



Pea-sized Berries Berry Touch Veraison

Grape Calendar

Read the product label and follow all safety precautions. Some grape varieties are sensitive to Sulphur, Copper, Flint, Pristine, or other products. See Table 6-5. *Relative Susceptibility of Grape Cultivars to Diseases*, page 158, for specific information.

For preharvest intervals, re-entry periods, maximum number of applications and chemical groups, see Table 6-4. *Products Used on Grapes*, page 156.

Resistance management

To delay development of resistance to fungicides, miticides and insecticides, follow resistance management guidelines outlined in *Pest Resistance to Insecticides, Fungicides, Miticides*, page 253. Products belonging to the same chemical group are grouped together in the calendar.

In addition, take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce rates below those specified on the label.
- Do not use Nova, Inspire, Sovran, Flint, Vivando, Lance, Cantus, Revus, or Pristine as eradicants when sporulating lesions of the target disease are present.
- Use sufficient water to provide thorough coverage.

Preharvest intervals

Contact the processors and wineries directly in regard to their preharvest interval policy. Preharvest intervals listed in Table 6-4. *Products Used on Grapes*, page 156, are taken from product labels. In some cases, regulations on residues in finished products (e.g. wine) are much more stringent. Many processors require longer preharvest intervals than stated on product labels. Some processors and wineries also have special restrictions for certain pest control products regarding number of applications or application after a certain crop stage. Consult the grape purchaser for more details.

Spray water volumes

Sufficient water volumes are necessary to provide complete coverage with grape fungicides, miticides and insecticides. Increased water volumes are necessary as the season progresses and canopies grow. Canopy management through hedging, leaf-pulling and shoot thinning, as well as proper sprayer calibration, are critical to ensure proper spray coverage. Sufficient coverage and efficacy are not possible if water volumes are inadequate. Some types of sprayers are able to provide sufficient coverage with less water than others. Consult equipment dealers or professional crop consultants about the amount of water needed to ensure adequate coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point. Read and follow water volume requirements on all product labels.

Products are listed according to insecticide and fungicide groups.

Diseases and Insects	Products	Rate	Comments
Bud burst to first leaf			
Climbing cutworm	• Altacor	285 g/ha	**Altacor:** Apply when cutworms start feeding on buds. Use no more than twice per season at recommended rate.
	• Pounce 384 EC	180 mL/ha	**Pounce:** Increase rate to 360 mL/ha if cutworms are large (2–3 cm). Apply in at least 450 L of water per ha. Spray trunk and soil surface within 0.5 m of the trunk in the evening. Do not disturb the soil for 5 days after spraying.
First leaf, 1.25–5 cm shoot length			
Phomopsis cane and leaf spot	• Supra Captan 80 WDG or Maestro 80 DF • Folpan 80 WDG	1.2 kg/1,000 L water 2 kg/ha 1.25 kg/ha	Spray susceptible varieties, especially if the weather is wet and there is a history of phomopsis in the vineyard. See Table 6-5. *Relative Susceptibility of Grape Cultivars to Diseases*, page 158. Use enough water to ensure complete coverage. Alternate row spraying will not give adequate protection from phomopsis.
3–5 leaves unfolded, 10–15 cm shoot length			
Phomopsis cane and leaf spot	• Supra Captan 80 WDG or Maestro 80 DF • Folpan 80 WDG	1.2 kg/1,000 L water 2 kg/ha 1.25 kg/ha	Spray susceptible varieties, especially if the weather is wet and there is a history of phomopsis in the vineyard. See Table 6-5. *Relative Susceptibility of Grape Cultivars to Diseases*, page 158. Use enough water to ensure complete coverage. Alternate row spraying will not give adequate protection from phomopsis.

Diseases and Insects	Products	Rate	Comments
Black rot	• Nova 40 W • Ferbam 76 WDG • Polyram DF	200 g/ha 2 kg/1,000 L water 2 kg/1,000 L water	Spray susceptible varieties, especially where there is a history of black rot and conditions are wet. Use enough water to ensure complete coverage. Alternate row spraying will not give adequate protection from black rot.
Powdery mildew	• Nova 40 W • Inspire • Quintec • Vivando SC • Microscopic Sulphur or Kumulus DF or Microthiol Disperss • MilStop • Serenade ASO • Purespray Green Spray Oil 13E	200 g/ha 292 mL/ha 300 mL/ha 750 mL/ha 4.5 kg/1,000 L water 12.6 kg/ha 12.6 kg/ha 2.8 kg/500 L water/ha 9–15 L/ha 10 L/1,000 L water/ha	Unless otherwise indicated, spray at 7–10 day intervals to protect expanding leaves and developing fruit clusters before symptoms appear. Spray at 7 day intervals if weather is conducive to disease or if rapid shoot growth that outgrows coverage is occurring. Alternate row spraying will not give adequate protection from powdery mildew. **Nova, Inspire, Quintec, Vivando:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Nova and Inspire:** Do not rotate between these products. **MilStop:** Apply in 500 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with pH adjusters, oil, or products not compatible with mild alkaline solutions. MilStop works as an eradicant and has no protective activity. **Serenade ASO:** Provides suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242. **Purespray Green Spray Oil 13E:** Provides suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. Summer oils can cause crop injury, depending on rate, cultivar, weather conditions, and recent pesticide applications. Do not apply less than 1,000 L water/ha (1% solution). Not all varieties have been tested for tolerance, so spray a small area of each variety to confirm tolerance prior to spraying the whole field. Do not apply within 14 days of Captan, Maestro, Folpan, Bravo, Echo, Pounce, Perm-Up, or products containing sulphur. Do not apply within 48 hours of freezing temperatures. Do not apply when temperatures are very high (above 25°C) or to crops under moisture stress. Do not apply just prior to rain. Read the label carefully for other precautions. See notes on *Mineral oil (Purespray Green Spray Oil 13E)*, page 252.
Shoot length, 20–25 cm			
Phylloxera (leaf form)	• Movento 240 SC • Assail 70 WP	365 mL/ha 80 g/ha	**Movento** works slowly so control may not be apparent for 2–3 weeks. Apply when galls are first observed, but do not apply before this growth stage because there will not be enough leaf area for product uptake. Movento will redistribute to young leaves as they develop. Consecutive applications should be at least 30 days apart. Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v (2 L/1,000 L). See label for further details.
Grape berry moth (GBM)	• Isomate-GBM Plus	500 dispensers/ha	**Isomate-GBM Plus:** Apply prior to first flight to reduce mating of grape berry moths. Most effective on vineyard blocks that are roughly square and larger than 2 ha. Border sprays of insecticide or higher rates of pheromone (1,000 dispensers per ha) may be required where grape berry moth pressure is high. Attach dispensers onto upper training wire of vines with a single twist. Monitor for GBM and other pests throughout the season to determine if insecticides are needed. Dispensers release pheromone for up to 150 days, depending on temperature. For more information, see *Using mating disruption to control grape berry moth*, page 250.

Diseases and Insects	Products	Rate	Comments
Phomopsis cane and leaf spot	• Supra Captan 80 WDG or Maestro 80 DF • Folpan 80 WDG	1.2 kg/1,000 L water 2 kg/ha 1.25 kg/ha	Spray susceptible varieties, especially if the weather is wet and there is a history of phomopsis in the vineyard. See Table 6-5. *Relative Susceptibility of Grape Cultivars to Diseases*, page 158. Use enough water to ensure complete coverage.
Black rot	• Nova 40 W • Sovran • Flint 50 WG • Pristine WG • Polyram DF • Ferbam 76 WDG	200 g/ha 240 g/ha 140 g/ha 735 g/ha 2 kg/1,000 L water 2 kg/1,000 L water	**Sovran** is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. **Flint:** Do not apply to Concord grapes or crop injury may occur. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Polyram:** Use no more than three times per season.
Powdery mildew	• Sovran • Flint 50 WG • Pristine WG • Lance WDG or Cantus WDG • Nova 40 W • Inspire • Quintec • Vivando SC • Microscopic Sulphur or Kumulus DF or Microthiol Disperss • MilStop • Serenade ASO • Purespray Green Spray Oil 13E	300 g/ha 140 g/ha 420–735 g/ha 315 g/ha 315 g/ha 200 g/ha 292 mL/ha 300 mL/ha 750 mL/ha 4.5 kg/1,000 L 12.6 kg/ha 12.6 kg/ha 2.8 kg/500 L water/ha 9–15 L/ha 10 L/1,000 L water/ha	Unless otherwise indicated, spray at 7–10 day intervals to protect expanding leaves and developing fruit clusters before symptoms appear. Spray at 7 day intervals if weather is conducive to disease or if rapid shoot growth that outgrows coverage is occurring. Alternate row spraying will not give adequate protection from powdery mildew. **Nova, Inspire, Quintec, Vivando, Pristine, Flint, Sovran, Lance, Cantus:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Pristine, Sovran, Flint:** Do not rotate within this group. **Sovran** is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. **Flint:** Do not apply to Concord grapes or crop injury may occur. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus. **Nova, Inspire:** Do not rotate within this group. **Vivando:** Do not apply at intervals of less than 14 days. **MilStop:** Apply in 500 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with pH adjusters, oil, or products not compatible with mild alkaline solutions. MilStop works as an eradicant and has no protective activity. **Serenade ASO:** Provides suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242. **Purespray Green Spray Oil 13E:** Provides suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. Summer oils can cause crop injury, depending on rate, cultivar, weather conditions, and recent pesticide applications. Do not apply less than 1,000 L water/ha (1% solution). Not all varieties have been tested for tolerance, so spray a small area of each variety to confirm tolerance prior to spraying the whole field. Do not apply within 14 days of Captan, Maestro, Folpan, Bravo, Echo, Pounce, Perm-Up, or products containing sulphur. Do not apply within 48 hours of freezing temperatures. Do not apply when temperatures are very high (above 25°C) or to crops under moisture stress. Do not apply just prior to rain. Read the label carefully for other precautions. See notes on *Mineral oil (Purespray Green Spray Oil 13E)*, page 252.

Diseases and Insects	Products	Rate	Comments
Downy mildew	• Revus • Sovran • Pristine WG • Polyram DF • Manzate 200 WP • Maestro 80 DF or Supra Captan 80 WDG • Folpan 80 WDG • Copper Spray • Guardsman Copper Oxychloride • Gavel 75 DF • Ridomil Gold MZ 68 WG	500 mL/ha 300 g/ha 675–735 g/ha 2 kg/1,000 L water 6.75 kg/ha 2 kg/ha 1.5 kg/1,000 L water 1.25 kg/ha 3 kg + 6 kg lime/ 1,000 L water 3 kg + 6 kg lime/ha 2.25 kg/ha 2.5 kg/ha	Spray at 7-10 day intervals to protect expanding leaves and developing fruit clusters. Spray at shorter intervals in rainy weather. If bloom is delayed or wet weather is expected, spray again. **Revus, Sovran, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray.Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/ Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Revus:** Use with a non-ionic adjuvant (0.125%, 1.25 L/1,000 L). Do not use Revus plus adjuvant tank-mixed with sulphur on sulphur-sensitive varieties. Use no more than four applications per season. **Sovran:** Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Pristine, Sovran:** Do not rotate between Pristine and Sovran. **Copper Spray, Guardsman Copper Oxychloride:** Do not apply on Seibel varieties (De Chaunac). **Ridomil Gold MZ:** Use no more than one prebloom and one postbloom application.
Immediate prebloom			
Grape berry moth (1st generation)	• Delegate WG • Success 480 SC or Entrust 80 W • Altacor • Dipel 2X DF • Pounce 384 EC or Perm-Up or Ambush 500 EC • Imidan 50 WP • Sevin XLR	280 g/ha 182 mL/ha 109 g/ha 285 g/ha 1.125 g/ha 360 mL/ha 360 mL/ha 275 mL/ha 1.9 kg/ha 5.25 L/ha	Where there is a history of early-season grape berry moth injury, apply an insecticide for first generation in enough water to ensure complete coverage. For resistance management, do not use insecticides from the same group for more than one generation. Within a generation, only one chemical group should be used. **Dipel 2X DF:** Re-application may be required 7–10 days later. See *Biopesticides for Insect Control*, page 247. **Delegate, Success, Entrust:** Provide suppression rather than control of grape berry moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. **Altacor, Delegate, Success, Entrust, Dipel:** Apply at first egg hatch (first sustained moth catch in pheromone traps), earlier than the traditional timing (upswing in moth numbers captured in traps) used for Pounce or Imidan. A second application may be necessary if flight is extended.
Japanese beetle	• Imidan 50 WP • Assail 70 WP	1.9 kg/ha 80 g/ha	Japanese beetle is a sporadic pest that feeds on over 300 plant species. Monitor to determine beetle presence and extent of feeding damage. Where damage is localized, spot-treatment may be adequate for control. Watch for re-infestation after treatment. **Imidan:** Be aware of current label changes with respect to restrictions and precautions. See Table 6-4, *Products used on Grapes*, page 156.
Leafhoppers	• Assail 70 WP • Clutch 50 WDG • Pounce 384 EC or Perm-Up or Ambush 500 EC • Sevin XLR • Surround WP	80 g/ha 100–140 g/ha 175 mL/ha 175 mL/ha 140 mL/ha 5.25 L/ha 50 kg /ha	Grape leafhopper (GLH), potato leafhopper (PLH) and three banded leafhopper (TBLH) are the three main species of leafhoppers that feed on grapes. **Surround WP:** May delay sugar accumulation. Closely monitor harvest parameters to determine best time to harvest. Use 50 kg/ha of Surround for the first two applications to establish the protectant layer, followed by 25 kg/ha in subsequent sprays. Re-apply to maintain complete coverage following heavy rain. Applications after veraison (when grapes begin to ripen) will adhere better to berries. Do not apply Surround postbloom on table grapes. See *Kaolin clay (Surround WP)*, page 247.

Diseases and Insects	Products	Rate	Comments
Phylloxera (leaf form)	• Movento 240 SC	365 mL/ha	**Movento** works slowly so control may not be apparent for 2–3 weeks. Movento will redistribute to young leaves as they develop. Consecutive applications should be at least 30 days apart. Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See label for further details.
	• Assail 70 WP	80 g/ha	
	• Clutch 50 WDG	140–210 g/ha	
Trace bloom (first cap fall)			
DO NOT APPLY INSECTICIDES WHILE GRAPES ARE IN BLOOM. SEE *BEE POISONING* ON PAGE 267.			
Black rot	• Nova 40 W	200 g/ha	Fruit clusters are highly susceptible to black rot from bloom to 4 weeks postbloom. **Sovran** is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. **Flint:** Do not apply to Concord grapes or crop injury may occur. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury.
	• Sovran	240 g/ha	
	• Flint 50 WG	140 g/ha	
	• Pristine WG	735 g/ha	
	• Polyram DF	2 kg/1,000 L water	
	• Ferbam 76 WDG	2 kg/1,000 L water	
Downy mildew	• Revus	500 mL/ha	Fruit clusters are highly susceptible to downy mildew from bloom until 4-6 weeks postbloom. Spray at 7–10 day intervals to protect expanding leaves and developing fruit clusters. Spray at shorter intervals in rainy weather. **Revus, Sovran, Pristine, Presidio:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Revus:** The use of a non-ionic adjuvant is recommended (0.125% 1.25 L/1,000 L water). Do not use Revus plus adjuvant tank-mixed with sulphur on sulphur-sensitive varieties. Use no more than four applications per season. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Sovran** is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. **Pristine, Sovran:** Do not rotate between these products. **Presidio:** Tank mix with a labelled rate of another fungicide registered for downy mildew, but with a different mode of action. **Copper Spray and Guardsman Copper Oxychloride:** Do not apply on Seibel varieties (De Chaunac). **Ridomil Gold MZ:** No more than one pre-bloom application.
	• Pristine WG	675–735 g/ha	
	• Sovran	300 g/ha	
	• Presidio	220–292 mL/ha	
	• Polyram DF	2 kg/1,000 L water	
	• Manzate 200 WP	6.75 kg/ha	
	• Maestro 80 DF or Supra Captan 80 WDG	2 kg/ha 1.5 kg/1,000 L water	
	• Folpan 80 WDG	1.25 kg/ha	
	• Gavel 75 DF	2.25 kg/ha	
	• Ridomil Gold MZ 68 WG	2.5 kg/ha	
	• Copper Spray	3 kg + 6 kg lime/ 1,000 L water	
	• Guardsman Copper Oxychloride	3 kg + 6 kg lime/ha	

Diseases and Insects	Products	Rate	Comments
Powdery mildew	• Sovran	300 g/ha	Fruit clusters are very susceptible to infection by powdery mildew from bloom through 4-6 weeks post-bloom. Unless otherwise indicated below, spray at 7–10 day intervals to protect expanding leaves and developing fruit clusters. Spray at 7-day intervals if weather is conducive to disease. **Nova, Inspire, Quintec, Vivando, Pristine, Flint, Sovran, Lance, Cantus:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Sovran:** is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. **Flint:** Do not apply to Concord grapes or crop injury may occur. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Sovran, Flint, Pristine:** Do not rotate among this group. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus. For resistance management, use no more than two sprays of any of these products per season. **Nova, Inspire:** Do not rotate between these products. **Vivando:** Do not apply at intervals of less than 14 days. **MilStop:** Apply in 500 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with pH adjusters, oil, or products not compatible with mild alkaline solutions. MilStop works as an eradicant and has no protective activity. **Serenade ASO:** Provides suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242. **Purespray Green Spray Oil 13E:** Provides suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. Summer oils can cause crop injury, depending on rate, cultivar, weather conditions, and recent pesticide applications. Do not apply less than 1,000 L water/ha (1% solution). Not all varieties have been tested for tolerance, so spray a small area of each variety to confirm tolerance prior to spraying the whole field. Do not apply within 14 days of Captan, Maestro, Folpan, Bravo, Echo, Pounce, Perm-Up, or products containing sulphur. Do not apply within 48 hours of freezing temperatures. Do not apply when temperatures are very high (above 25°C) or to crops under moisture stress. Do not apply just prior to rain. Read the label carefully for other precautions. See notes on *Mineral oil (Purespray Green Spray Oil 13E)*, page 252.
	• Flint 50 WG	140 g/ha	
	• Pristine WG	420–735 g/ha	
	• Lance WDG	315 g/ha	
	• or Cantus WDG	315 g/ha	
	• Nova 40 W	200 g/ha	
	• Inspire	292 mL/ha	
	• Quintec	300 mL/ha	
	• Vivando SC	750 mL/ha	
	• Microscopic Sulphur	4.5 kg/1,000 L water	
	or Kumulus DF	12.6 kg/ha	
	or Microthiol Disperss	12.6 kg/ha	
	• MilStop	2.8 kg/500 L water/ha	
	• Serenade ASO	9–15 L/ha	
	• Purespray Green Spray Oil 13E	10 L/1,000 L water/ha	

Diseases and Insects	Products	Rate	Comments
Botrytis bunch rot	• Rovral	1.5 kg/ha	If the bloom/postbloom period is wet, spray immediately to control latent infections in susceptible varieties (Gamay Noir, Pinot Noir, Pinot Gris, Riesling, Chardonnay and Seyval Blanc). Direct this spray at the fruiting zone. **Vangard, Scala:** Use once and then rotate to a different group. Use no more than two applications of either product per season. **Elevate:** Do not apply Elevate if rainfall is expected within six hours after application. **Pristine:** At high rate provides suppression of bunch rot. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control. **Serenade ASO:** Provides suppression of botrytis bunch rot. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
	• Vangard 75 WG	750 g/ha	
	• Scala SC	2 L/ha	
	• Elevate 50 WDG	1.12 kg/ha	
	• Pristine WG	420–735 g/ha	
	• Serenade ASO	5–15 L/ha	
Immediate postbloom to early fruit set			
Leafhoppers	• Assail 70 WP	80 g/ha	Grape leafhopper (GLH), potato leafhopper (PLH) and three banded leafhopper (TBLH) are the three main species of leafhoppers that feed on grapes. **Surround WP:** May delay sugar accumulation. Closely monitor harvest parameters to determine best time to harvest. Use 50 kg/ha of Surround for the first two applications to establish the protectant layer, followed by 25 kg/ha in subsequent sprays. Re-apply to maintain complete coverage following heavy rain. Applications after veraison (when grapes begin to ripen) will adhere better to berries. Do not apply Surround postbloom on table grapes. See *Kaolin clay (Surround WP)*, page 247.
	• Clutch 50 WDG	100–140 g/ha	
	• Pounce 384 EC	175 mL/ha	
	or Perm-Up	175 mL/ha	
	or Ambush 500 EC	140 mL/ha	
	• Sevin XLR	5.25 L/ha	
	• Surround WP	50 kg/ha	
Phylloxera (leaf form)	• Movento 240 SC	365 mL/ha	Only French hybrid and Vinifera varieties are susceptible to this pest. **Movento:** has slow activity; control may not be apparent for 2–3 weeks. Consecutive applications should be at least 30 days apart. Movento will redistribute to young leaves as they develop. Use no more than twice per season at recommended rate. Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details.
	• Assail 70 WP	80 g/ha	
	• Clutch 50 WDG	140–210 g/ha	
Japanese beetle	• Imidan 50 WP	2.5 kg/ha	Japanese beetle is a sporadic pest that feeds on over 300 plant species. Monitor to determine beetle presence and extent of feeding damage. Where damage is localized, spot-treatment may be adequate for control. Watch for re-infestation after treatment. **Imidan:** Be aware of current label changes with respect to restrictions and precautions. See Table 6-4, *Products Used on Grapes*, page 156.
	• Assail 70 WP	80 g/ha	
Black rot	• Nova 40 W	200 g/ha	**Sovran** is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. **Flint:** Do not apply to Concord grapes or crop injury may occur. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury.
	• Sovran	240 g/ha	
	• Flint 50 WG	140 g/ha	
	• Pristine WG	735 g/ha	
	• Polyram DF	2 kg/1,000 L water	

Diseases and Insects	Products	Rate	Comments
Powdery mildew	• Sovran • Flint 50 WG • Pristine WG • Lance WDG or Cantus WDG • Nova 40 W • Inspire • Quintec • Vivando SC • Microscopic Sulphur or Kumulus DF or Microthiol Disperss • MilStop • Serenade ASO • Purespray Green Spray Oil	300 g/ha 140 g/ha 420–735 g/ha 315 g/ha 315 g/ha 200 g/ha 292 mL/ha 300 mL/ha 750 mL/ha 4.5 kg/1,000 L water 12.6 kg/ha 12.6 kg/ha 5.6 kg/1,000 L water/ha 9–15 L/ha 10 L/1,000 L water/ha	Fruit clusters are highly susceptible to powdery mildew from bloom through 4–6 weeks postbloom. It is important to maintain protective coverage. Intervals between sprays should be 7–10 days. Spray at 7-day intervals if weather is conducive to disease. **Nova, Inspire, Quintec, Vivando, Pristine, Flint, Sovran, Lance, Cantus:** To manage resistance for each of these fungicides, use a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Sovran:** is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. **Flint:** Do not apply to Concord grapes or crop injury may occur. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Pristine, Sovran, Flint:** Do not rotate within this group. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus. **Nova and Inspire:** Do not rotate between these products. **Vivando:** Do not apply at intervals of less than 14 days. **MilStop:** Apply in 1,000 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with pH adjusters, oil, or products not compatible with mild alkaline solutions. MilStop works as an eradicant and has no protective activity. **Serenade ASO:** Provides suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242. **Purespray Green Spray Oil 13E:** Provides suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. Summer oils can cause crop injury, depending on rate, cultivar, weather conditions, and recent pesticide applications. Do not apply less than 1,000 L water/ha (1% solution). Not all varieties have been tested for tolerance, so spray a small area of each variety to confirm tolerance prior to spraying the whole field. Do not apply within 14 days of Captan, Maestro, Folpan, Bravo, Echo, Pounce, Perm-Up, or products containing sulphur. Do not apply within 48 hours of freezing temperatures. Do not apply when temperatures are very high (above 25°C) or to crops under moisture stress. Do not apply just prior to rain. Read the label carefully for other precautions. See notes on *Mineral oil (Purespray Green Spray Oil 13E)*, page 252.

Diseases and Insects	Products	Rate	Comments
Downy mildew	• Revus	500 mL/ha	Fruit clusters are highly susceptible to downy mildew until 4–6 weeks postbloom. Intervals between sprays should be 7–10 days. Under rainy conditions use the shorter interval. **Revus, Sovran, Pristine, Presidio:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Revus:** The use of a non-ionic adjuvant is recommended (0.125% v/v). Do not use Revus plus adjuvant tank-mixed with sulphur on sulphur-sensitive varieties. Use no more than four applications per season. **Sovran:** Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Pristine and Sovran:** Do not rotate Pristine with Sovran. **Presidio:** Tank mix with a labelled rate of another fungicide registered for downy mildew, but with a different mode of action. **Copper Spray and Guardsman Copper Oxychloride:** Do not apply on Seibel varieties (De Chaunac). **Ridomil Gold MZ:** No more than one application postbloom.
	• Pristine WG	675–735 g/ha	
	• Sovran	300 g/ha	
	• Presidio	220–292 mL/ha	
	• Polyram DF	2 kg/1,000 L water	
	• Manzate 200 WP	6.75 kg/ha	
	• Maestro 80 DF or Supra Captan 80 WDG	3 kg/ha 1.5 kg/1,000 L water	
	• Folpan 80 WDG	1.25 kg/ha	
	• Copper Spray	3 kg + 6 kg lime/1,000 L water	
	• Guardsman Copper Oxychloride	3 kg + 6 kg lime/ha	
	• Gavel 75 DF	2.25 kg/ha	
	• Ridomil Gold MZ 68 WG	2.5 kg/ha	
Botrytis bunch rot	• Rovral	1.5 kg/ha	An immediate postbloom spray may provide control of latent infections in varieties prone to botrytis bunch rot (e.g. Gamay Noir, Pinot Noir, Pinot Gris, Riesling, Chardonnay and Seyval Blanc), if the bloom/postbloom period is wet. Direct this spray at the fruiting zone. For resistance management, rotate among fungicide groups between applications. **Vangard, Scala:** Do not rotate between these products. **Elevate:** Do not apply Elevate if rainfall is expected within six hours after application. **Pristine:** At high rate provides suppression of bunch rot. **Serenade ASO:** Provides suppression of bunch rot. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
	• Vangard 75 WG	750 g/ha	
	• Scala SC	2 L/ha	
	• Elevate 50 WDG	1.12 kg/ha	
	• Pristine WG	420–735 g/ha	
	• Serenade ASO	5–15 L/ha	
Berries pea-sized			
Grape berry moth (GBM) (2nd generation)	• Delegate WG	280 g/ha	Where mating disruption for GBM is in place and monitoring indicates good control, an insecticide is not needed at this time. Where berry moth is a regular problem, use one of these products. Apply sprays in high water volumes to ensure complete coverage in the fruiting zone. For resistance management, do not use insecticides from the same group for more than one generation. Within a generation, only one insecticide group should be used. **Delegate, Success, Entrust:** Provide suppression rather than control of grape berry moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13. **Altacor, Delegate, Success, Entrust:** Apply at first egg hatch (first sustained moth catch in pheromone traps), earlier than the traditional timing (upswing in moth numbers captured in traps) used for Pounce, Perm-Up, Ambush or Imidan. A second application may be necessary if flight is extended. **Imidan:** Be aware of current label changes with respect to restrictions and precautions. See Table 6-4, *Products used on Grapes*, page 156.
	• Success 480 SC or Entrust 80 W	182 mL/ha 109 g/ha	
	• Altacor	285 g/ha	
	• Pounce 384 EC or Perm-Up or Ambush 500 EC	360 mL/ha 360 mL/ha 275 mL/ha	
	• Imidan 50 WP	3.1 kg/ha	

Diseases and Insects	Products	Rate	Comments
Japanese beetle	• Imidan 50 WP • Assail 70 WP	2.5 kg/ha 80 g/ha	Japanese beetle is a sporadic pest that feeds on over 300 plant species. Monitor to determine beetle presence and extent of feeding damage. Where damage is localized, spot-treatment may be adequate for control. Watch for re-infestation after treatment. **Imidan:** Be aware of current label changes with respect to restrictions and precautions. See Table 6-4, *Products Used on Grapes*, page 156.
Grape phylloxera (leaf form)	• Movento 240 SC • Assail 70 WP • Clutch 50 WDG	365 mL/ha 80 g/ha 140–210 g/ha	**Movento** has slow activity; control may not be apparent for 2–3 weeks. Consecutive applications should be at least 30 days apart. Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2% v/v. See the label for further details.
Powdery mildew	• Flint 50 WG • Sovran • Pristine WG • Lance WDG or Cantus WDG • Nova 40 W • Inspire • Quintec • Vivando SC • Microscopic Sulphur or Kumulus DF or Microthiol Disperss • MilStop • Serenade ASO	140 g/ha 300 g/ha 420–735 g/ha 315 g/ha 315 g/ha 200 g/ha 292 mL/ha 300 mL/ha 750 mL/ha 4.5 kg/1,000 L water 12.6 kg/ha 12.6 kg/ha 5.6 kg/1,000 L water/ha 9–15 L/ha	Fruit clusters are highly susceptible to powdery mildew until 4–6 weeks after bloom. Spray at 7–10 day intervals to maintain protective coverage. Spray at 7 day intervals in rainy weather. **Nova, Inspire, Quintec, Vivando, Pristine, Flint, Sovran, Lance, Cantus:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Sovran** is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. **Flint:** Do not apply to Concord grapes or crop injury may occur. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Pristine, Flint and Sovran:** Do not rotate within this group. **Pristine. Lance and Cantus**: Do not rotate Pristine with Lance or Cantus. For resistance management, use no more than two applications per season. **Nova and Inspire:** Do not rotate between these products. **Vivando:** Do not apply at intervals of less than 14 days. **MilStop:** Apply in 1,000 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with pH adjusters, oil, or products not compatible with mild alkaline solutions. MilStop works as an eradicant and has no protective activity. **Serenade ASO:** Provides suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.

Diseases and Insects	Products	Rate	Comments
Downy mildew	• Revus	500 mL/ha	Fruit clusters are highly susceptible to downy mildew until 4-6 weeks postbloom. Intervals between sprays should be 7–10 days. Under rainy conditions use the shorter interval. **Revus, Pristine, Presidio:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. See Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257 for fungicide groups. Do not use if sporulating lesions are present. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Revus:** The use of a non-ionic adjuvant is recommended (0.125%, 1.25 L/1,000 L). Do not use Revus plus adjuvant tank-mixed with sulphur on sulphur-sensitive varieties. Use no more than 4 applications per season. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Presidio:** Tank mix with a labelled rate of another fungicide registered for downy mildew, but with a different mode of action. **Copper Spray and Guardsman Copper Oxychloride:** Do not apply on Seibel varieties (De Chaunac). **Ridomil Gold MZ:** No more than one application post bloom. Consult label for pre-harvest interval.
	• Pristine WG	675–735 g/ha	
	• Presidio	220–292 mL/ha	
	• Folpan 80 WDG	1.25 kg/ha	
	• Supra Captan 80 WDG or Maestro 80 DF	1.5 kg/1,000 L water 3 kg/ha	
	• Polyram DF	2 kg/1,000 L water	
	• Manzate 200 WP	6.75 kg/ha	
	• Gavel 75 DF	2.25 kg/ha	
	• Copper Spray	3 kg + 6 kg lime/ 1,000 L water	
	• Guardsman Copper Oxychloride	3 kg + 6 kg lime/ha	
	• Ridomil Gold MZ 68 WG	2.5 kg/ha	
Black rot	• Nova 40 W	200 g/ha	**Sovran** is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. **Flint:** Do not apply to Concord grapes or crop injury may occur. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Pristine, Sovran and Flint:** Do not rotate within this group.
	• Flint 50 WG	140 g/ha	
	• Sovran	240 g/ha	
	• Pristine WG	735 g/ha	
	• Polyram DF	2 kg/1,000 L water	

Diseases and Insects	Products	Rate	Comments
Berry touch to cluster closure Check product labels and Table 6-4. *Products Used on Grapes*, page 156, for preharvest intervals.			
Powdery mildew	• Lance WDG or Cantus WDG • Pristine WG • Nova 40 W • Inspire • Quintec • Vivando SC • Microscopic Sulphur or Kumulus DF or Microthiol Disperss • MilStop • Serenade ASO	315 g/ha 315 g/ha 420–735 g/ha 200 g/ha 292 mL/ha 300 mL/ha 750 mL/ha 4.5 kg/1,000 L water 12.6 kg/ha 12.6 kg/ha 5.6 kg/1,000 L water/ha 9–15 L/ha	Check product labels and Table 6-4. *Products Used On Grapes*, page 156, for days to harvest intervals. **Nova, Inspire, Quintec, Vivando, Pristine, Flint, Sovran, Lance, Cantus:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus. For resistance management, use no more than two applications of these products per season. **Nova and Inspire:** Do not rotate between these products. **Vivando:** Do not apply at intervals of less than 14 days. **MilStop:** Apply in 1,000 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with pH adjusters, oil, or products not compatible with mild alkaline solutions. MilStop works as an eradicant and has no protective activity. **Serenade ASO:** Provides suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
Downy mildew	• Revus • Pristine WG • Presidio • Folpan 80 WDG • Supra Captan 80 WDG or Maestro 80 DF • Polyram DF • Gavel 75 DF • Copper Spray • Guardsman Copper Oxychloride	500 mL/ha 675–735 g/ha 220–292 mL/ha 1.25 kg/ha 1.5 kg/1,000 L water 3 kg/ha 2 kg/1,000 L water 2.25 kg/ha 3 kg + 6 kg lime/ 1,000 L water 3 kg + 6 kg lime/ha	Check product labels and Table 6-4. *Products Used On Grapes*, page 156, for days to harvest intervals. **Revus, Pristine, Presidio:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/ Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Revus:** The use of a non-ionic adjuvant is recommended (0.125% v/v). Do not use Revus plus adjuvant tank-mixed with sulphur on sulphur-sensitive varieties. Use no more than four applications per season. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Presidio:** Tank mix with a labelled rate of another fungicide registered for downy mildew, but with a different mode of action. **Copper Spray and Guardsman Copper Oxychloride:** Do not apply on Seibel varieties (De Chaunac).
Black rot	Use one of the materials listed under **Berries pea-sized.**		This spray is necessary only if black rot is severe and new infections continue to occur.

Diseases and Insects	Products	Rate	Comments
Botrytis bunch rot	• Rovral • Vangard 75 WG • Scala SC • Elevate 50 WDG • Pristine WG • Serenade ASO	1.5 kg/ha 750 g/ha 2 L/ha 1.12 kg/ha 420–735 g/ha 5–15 L/ha	Direct this spray at the fruiting zone. Many of the Vinifera and French hybrid varieties with tight clusters are susceptible to botrytis bunch rot, (e.g. Gamay Noir, Pinot Noir, Pinot Gris, Riesling, Chardonnay and Seyval Blanc). For resistance management, rotate among fungicide groups between applications. **Vangard, Scala:** Do not rotate between these products. Use no more than twice per season. **Elevate:** Do not apply Elevate if rainfall is expected within six hours after application. **Pristine:** At high rate provides suppression of bunch rot. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. **Serenade ASO:** Provides suppression of bunch rot. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
European red mite	• Nexter • Envidor 240 SC • Acramite 50 WS • Agri-Mek 1.9% EC	600 g/ha 750 mL/ha 851 g/ha 585–1,170 mL/ha	A miticide may be required if significant bronzing of mid-shoot leaves occurs as a result of mite infestation. Stressed vines will show injury earlier than healthy vines. Monitor 7–10 days after application to evaluate mite control. Use any miticide only once per season and rotate as an effective resistance management strategy. **Nexter** is most effective against active nymphal stages, not adults. **Envidor** is effective on mite eggs, nymphs and adult females. Envidor works slowly, especially in cool weather. Control may not be apparent for 2–3 weeks. Apply before mite populations build up. **Agri-Mek:** Use 585-875 mL/ha for low to moderate infestations and 1,170 mL /ha for severe infestations. Apply when mites first appear and a second application if monitoring indicates it is necessary at a 21-day interval. Apply in combination with a non-ionic surfactant in a minimum of 470 L of water per hectare. Do not apply Agri-Mek within 10 days of Captan or Maestro because of potential of phytotoxicity.
Beginning of ripening (veraison) through harvest **Check product labels and Table 6-4. *Products Used on Grapes*, page 156, for preharvest intervals.**			
Grape berry moth (GBM) (about mid–late August)	• Altacor • Pounce 384 EC or Perm-Up or Ambush 500 EC • Imidan 50 WP • Delegate WG • Success 480 SC or Entrust 80 W	285 g/ha 360 mL/ha 360 mL/ha 275 mL/ha 3.1 kg/ha 280 g/ha 182 mL/ha 109 g/ha	Where mating disruption for GBM is in place and monitoring indicates good control, an insecticide may not be needed at this time. Where berry moth is a regular problem, use one of these products. Apply sprays in high water volumes to ensure complete coverage. Check the interval to harvest. A spray may be needed on late varieties to control the brood that emerges in late August. Border sprays of conventional insecticides may be very effective. **Altacor, Delegate:** Apply at first egg hatch (first sustained moth catch in traps), earlier than the traditional timing (upswing in moth numbers captured in pheromone traps) used for Pounce, Perm-Up, Ambush or Imidan. Use no more than twice per season at recommended rate. **Imidan:** Be aware of current label with respect to restrictions and precautions. **Success, Entrust:** Provide suppression of GBM. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control.

Diseases and Insects	Products	Rate	Comments
Powdery mildew	• Lance WDG or Cantus WDG	315 g/ha 315 g/ha	Vinifera and French hybrid varieties are more susceptible and may require extra sprays. Check product labels and Table 6-4. *Products Used On Grapes*, page 156, for days to harvest intervals. **Nova, Inspire, Quintec, Vivando, Pristine, Flint, Sovran, Lance, Cantus:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus. For resistance management, use no more than two applications of these products per season. **Nova and Inspire:** Do not rotate between these products. **Vivando:** Do not apply at intervals of less than 14 days. **MilStop:** Apply in 1,000 L water per ha. MilStop creates a mildly alkaline solution. Do not tank mix with pH adjusters, oil, or products not compatible with mild alkaline solutions. MilStop works as an eradicant and has no protective activity. **Serenade ASO:** Provides suppression of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
	• Pristine WG	420–735 g/ha	
	• Nova 40 W	200 g/ha	
	• Inspire	292 mL/ha	
	• Quintec	300 mL/ha	
	• Vivando SC	750 mL/ha	
	• Microscopic Sulphur or Kumulus DF or Microthiol Disperss	4.5 kg/1,000 L water 12.6 kg/ha 12.6 kg/ha	
	• MilStop	5.6 kg/1,000 L water/ha	
	• Serenade ASO	9–15 L/ha	
Downy mildew	• Revus	500 mL/ha	Check product labels and Table 6-4. *Products Used On Grapes*, page 156, for days to harvest intervals. **Revus, Pristine, Presidio:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/ Bactericide Groups Based on Sites of Action*, page 257. Unless indicated below, use each fungicide group only twice per season. These products are locally systemic. Consult labels for information on drying time required before rain. **Revus:** The use of a non-ionic adjuvant is recommended (0.125% v/v). Do not use Revus plus adjuvant tank-mixed with sulphur on sulphur-sensitive varieties. Use no more than four applications per season. **Pristine:** When used as directed for the control of black rot, powdery and/or downy mildew, Pristine will help reduce the spread of anthracnose. Do not use on Concord, Fredonia or related varieties due to possible injury. **Presidio:** Tank mix with a labelled rate of another fungicide registered for downy mildew, but with a different mode of action. **Copper Spray and Guardsman Copper Oxychloride:** Do not apply on Seibel varieties (De Chaunac).
	• Pristine WG	675–735 g/ha	
	• Presidio	220–292 mL/ha	
	• Folpan 80 WDG	1.25 kg/ha	
	• Supra Captan 80 WDG or Maestro 80 DF	1.5 kg/1,000 L water 3 kg/ha	
	• Polyram DF	2 kg/1,000 L water	
	• Copper Spray	3 kg + 6 kg lime/ 1,000 L water	
	• Guardsman Copper Oxychloride	3 kg + 6 kg lime/ha	
Slugs and snails	• Sluggo Professional	25 kg/ha	Apply higher rate of 50 kg/ha if population is very high. Apply when infestation begins. Re-apply as the bait is consumed or at least every 2 weeks if slugs and snails continue to be a problem.

Diseases and Insects	**Products**	**Rate**	**Comments**
Special sprays (when monitoring indicates the need)			
Botrytis bunch rot	• Vangard 75 WG • Scala SC • Elevate 50 WDG • Pristine WG • Serenade ASO	750 g/ha 2 L/ha 1.12 kg/ha 420–735 g/ha 5–15 L/ha	This spray is necessary for tight-clustered, thin-skinned varieties. If conditions are warm and wet through the preharvest period, a second spray may be needed. Direct this spray to the fruiting zone. **Vangard, Scala:** Do not rotate between these products. **Pristine:** At high rate provides suppression of bunch rot. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. **Serenade ASO:** Provides suppression of bunch rot . See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control, and *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
Erineum mite	• Kumulus DF or Microthiol Disperss	3.4 kg/ha 3.4 kg/ha	Apply at pre-bloom immediately after the first evidence of erineum mite development and again at mid-season.
Multicoloured Asian lady beetle	• Ripcord 400 EC • Malathion 85 E	150 mL/ha 880 mL/ha	Lady beetles are not a problem until very close to harvest. Begin monitoring around mid-August and continue for each cultivar until harvested. Early presence of lady beetles is not an immediate concern, because they can arrive and leave an area rapidly. Discuss beetle thresholds and product restrictions with the proposed purchaser of grapes before taking action. Continue to monitor after treatment; re-infestation may occur before harvest. **Ripcord:** Cannot be used on juice grapes destined for export to the US.

Preharvest intervals

Contact the processors and wineries directly in regard to their preharvest interval policy. Preharvest intervals listed in Table 6-4. *Products Used on Grapes,* on this page, are taken from product labels. In some cases, regulations on residues in finished products (e.g. wine) are much more stringent. Many processors require longer preharvest intervals than stated on product labels. Some processors and wineries also have special restrictions for certain pest control products regarding number of applications or application after a certain crop stage. Consult the grape purchaser for more details.

Table 6-4. Products Used on Grapes

Use this table as a guide, but refer to product label for specific information.

The **pre-harvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects. Where maximum number of applications is not listed, it is not specified on the label.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry [1]	Maximum number of applications per year (on label)
Products used to control or suppression of insects and mites						
Acramite 50 WS	27925	bifenazate	25	14 days	12 hours/1 day[2]	1
Agri-Mek 1.9% EC	24551	abamectin	6	28 days	12 hours/13+ days[2]	2
Altacor	28981	chlorantraniliprole	28	14 days	12 hours	2 at recommended rate
Ambush 500 EC	14882	permethrin	3	7 days		
Assail 70 WP	27128	acetamiprid	4	3 days	12 hours/5 days[2]	2
Clutch 50 WDG	29382	clothianidin	4A	1 day	12 hours	2
Delegate WG	28778	spinetoram	5	7 days	12 hours	3
Dipel 2X DF	26508	*Bacillus thuringiensis*	11	0 days		6
Entrust 80 W	27825	spinosad	5	7 days	when dried/7 days[2]	3
Envidor 240 SC	28051	spirodiclofen	23	14 days	12 hours/2 days[2]	1
Imidan 50 WP	23006	phosmet	1B	14 days	14 days	3
Malathion 85 E	8372	malathion	1B	3 days		1
Movento 240 SC	28953	spirotetramat	23	7 days	12 hours	max. 920 mL/ha/yr
Nexter	25135	pyridaben	21	25 days	24 hours	1
Perm-Up	28877	permethrin	3	21 days	12 hours	
Pounce 384 EC	16688	permethrin	3	21 days		2
Ripcord 400 EC	15738	cypermethrin	3	2 days/7 days[3]		2
Sevin XLR	27876	carbaryl	1A	5 days[4]		
Sluggo Professional	30025	ferric phosphate		14 days		
Success 480 SC	26835	spinosad	5	7 days	when dried/7 days[2]	3
Surround WP	27469	kaolin		0 days		

A blank cell indicates the information is not specified on the product label.

[1] Re-entry periods for cane girdling and cane tying are not included here. See label for restrictions on these unusual activities.

[2] Re-entry period/exceptions are as follows: re-entry/hand labour (eg. training, thinning, leaf pulling, hand harvest).

[3] Machine harvest/hand harvest.

[4] Check with processor and winery for wine grapes.

[5] 21 days for wine grapes. 1 day for table grapes.

NC = Not classified.

U8 = Unknown.

Table 6-4. Products Used on Grapes (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry[1]	Maximum number of applications per year (on label)
Products used for control or suppression of diseases						
Cantus WDG	30141	boscalid	7	14 days	12 hours	5
Copper Spray	19146	copper oxychloride	M	1 day[4]	48 hours	
Elevate 50 WDG	25900	fenhexamid	17	7 days	4 hours	3
Ferbam 76 WDG	20136	ferbam	M	7 days		
Flint 50 WG	27529	trifloxystrobin	11	14 days	12 hours/5 days[2]	4
Folpan 80 WDG	27733	folpet	M	1 day	24 hours	2
Gavel 75 DF	26842	zoxamide + mancozeb	22+M	66 days	48 hours	6
Guardsman Copper Oxychloride	13245	copper oxychloride	M	1 day[4]	48 hours	7
Inspire	30004	difenoconazole	3	7 days	48 hours	2
Kumulus DF	18836	sulphur	M	21 days[5]	24 hours	
Lance WDG	27495	boscalid	7	14 days	12 hours	5
Maestro 80 DF	26408	captan	M	7 days	72 hours	
Manzate 200 WP	10526	mancozeb	M	30 days		
Microscopic Sulphur	14653	sulphur	M	21 days[5]	24 hours	
Microthiol Disperss	29487	sulphur	M	21 days[5]	24 hours	8
MilStop	28095	potassium bicarbonate	NC	0 days	4 hours	10
Nova 40 W	22399	myclobutanil	3	14 days		5
Polyram DF	20087	metiram	M	45 days		3
Presidio	30051	fluopicolide	43	21 days	12 hours/8 days[2]	4
Pristine WG	27985	pyraclostrobin + boscalid	11+7	14 days	when dried/ 21 days[2]	6
Purespray Green Spray Oil 13E	27666	mineral oil	U		12 hours	
Quintec	29755	quinoxyfen	13	14 days	12 hours	5
Revus	29074	mandipropamid	40	14 days	12 hours	4
Ridomil Gold MZ 68 WG	28893	metalaxyl + mancozeb	4+M	66 days	24 hours	1 prebloom 1 postbloom
Rovral	15213	iprodione	2	before bunch closure[4]	12 hours	2
Scala SC	28011	pyrimethanil	9	7 days	12 hours/24 hours[2]	3
Serenade ASO	28626	*Bacillus subtilis*	44	0 days		
Sovran	26257	kresoxim-methyl	11	14 days	48 hours	4
Supra Captan 80 WDG	24613	captan	M	7 days	72 hours	
Vangard 75 WG	25509	cyprodinil	9	7 days	48 hours	2
Vivando SC	29765	metrafenone	U8	14 days	12 hours	6

A blank cell indicates the information is not specified on the product label.

[1] Re-entry periods for cane girdling and cane tying are not included here. See label for restrictions on these unusual activities.

[2] Re-entry period/exceptions are as follows: re-entry/hand labour (eg. training, thinning, leaf pulling, hand harvest).

[3] Machine harvest/hand harvest.

[4] Check with processor and winery for wine grapes.

[5] 21 days for wine grapes. 1 day for table grapes.

NC = Not classified.

U8 = Unknown.

Notes on grape pests

Relative susceptibility of grape cultivars to diseases

Table 6-5. *Relative Susceptibility of Grape Cultivars to Diseases,* on this page, provides a relative rating of grape variety susceptibility based on observations in Ontario and northeast United States under average conditions. Under adverse weather conditions, such as extended cool weather, any given variety may be more seriously affected. See Table 6-6. *Activity of Fungicides on Grape Diseases,* page 159 for effect of fungicides on various grape diseases.

Table 6-5. Relative Susceptibility of Grape Cultivars to Diseases

— = Relative susceptibility is unknown; + = Slightly susceptible; ++ = Moderately susceptible; +++ = Highly susceptible; ++++ = Extremely susceptible.

Cultivar	Type[a]	Eutypa dead arm	Phomopsis cane blight	Black rot[b]	Downy mildew	Powdery mildew	Botrytis bunch rot	Phytotoxic chemical sensitivity[c]
Vinifera Wine								
Auxerrois	V	—	++	—	+	+++	+++	
Cabernet Franc	V	—	++	+++	++	+++	+	
Cabernet Sauvignon	V	++	++	+++	++	+++	+	
Chardonnay	V	+	++	+++	+++	++++	+++	
Gamay	V	+	+	++	++	+++	++	
Gewurztraminer	V	++	—	+++	++	+++	+++	
Merlot	V	—	+	+++	++	+++	++	2
Pinot Blanc	V	—	—	+++	++	+++	+++	
Pinot Gris	V	—	—	+++	++	+++	+++	
Pinot Noir	V	—	—	+++	++	+++	+++	
Riesling	V	+	+	+++	++	+++	+++	
Sauvignon Blanc	V	—	—	++	++	++	+++	
Zweigeltrebe	V	—	++	+++	++	+++	+	
Hybrid Wine								
Baco Noir	FH	—	++	+	+	++	+++	1
Chambourcin	FH	—	+	++	++	++	+	1
De Chaunac	FH	+	+++	+	+	++	+	1
Frontenac	AH	?	+	++	+	++	+	
Marechal Foch	FH	++	++	+	+	++	+	1
Seyval Blanc	FH	—	++	++	++	+++	+++	
S.V. 23-512	FH	—	+	—	—	++	—	
Vidal 256	FH	—	+	+	++	++	+++	2
Juice & Table								
Concord	L	+	++	++	++	++	+	1,2,3
Elvira	L	+++	+++	++	+	++	++	3
Fredonia	L	+	++	++	+++	++	+	
Himrod	AH	—	+	++	+	++	+	
Niagara	L	++	++	+++	+++	++	+	2
N.Y. Muscat	L	+	—	+	+	++	+	
Sovereign Coronation	L	—	+	—	+++	+++	—	

[a] Species type.

[b] Black rot is more serious adjacent to bush or similar areas with poor air drainage.

[c] These notes are based on grower experience and could vary under stress conditions. No entry in this column indicates that no chemical sensitivity has been observed.

1 = Sulphur sensitive.
2 = Copper sensitive.
3 = Flint and Pristine sensitive.

L = Labrusca.
AH = American hybrid.
FH = French hybrid.
V = Vinifera (vinifera varieties not included in this chart are considered susceptible to powdery mildew, downy mildew and black rot).

Table 6-6. Activity of Fungicides on Grape Diseases

Ratings in shaded cells indicate the disease is listed on the product label for control or suppression. Please see the product label or crop calendars for registered uses. Use fungicides only for the crop and disease combinations listed on the product label. Additional information is provided in this table to assist the grower in choosing the best fungicide for control of diseases listed on the product label.

Group	Fungicide	Anthracnose	Phomopsis cane and leaf spot	Black rot	Downy mildew	Powdery mildew	Botrytis bunch rot	Activity
M	Copper Spray	0	+	+	++	++	0	Prot/PI[1]
M	Guardsman Copper Oxychloride	0	+	+	++	++	0	Prot/PI[1]
M	Kumulus DF	+	+	0	0	+++	0	Prot/ PI/ AS/ E
M	Microscopic Sulphur	+	+	0	0	+++	0	Prot/PI/AS/E
M	Microthiol Disperss	+	+	0	0	+++	0	Prot/PI/AS/E
M	Lime Sulphur	++	0	0	0	+	0	Prot
M	Ferbam 76 WDG	++	+++	+++	++	0	0	Prot
M	Polyram DF	++	+++	+++	+++	0	0	Prot
M	Supra Captan 80 WDG	++	+++	++	+++	0	0	Prot
M	Folpan 80 WDG	++	+++	++	+++	0	0	Prot
M	Maestro 80 DF	++	+++	++	+++	0	0	Prot
2	Rovral	0	0	0	0	0	++	Prot/ PI/ AS
3	Inspire	+++	0	+++	0	+++	0	Prot/ PI/ AS
3	Nova 40 W	+++	0	+++	0	+++	0	Prot/ PI/ AS
4	Ridomil Gold MZ 68 WG	0	+	+	+++	0	0	Prot/ PI/ AS
7	Cantus WDG	0	0	0	0	0	+	Prot/ PI/ AS
7	Lance WDG	0	0	0	0	0	+	Prot/ PI/ AS
9	Scala SC	0	0	0	0	0	+++	Prot/ PI/ AS
9	Vangard 75 WG	0	0	0	0	0	+++	Prot/ PI/ AS
11	Flint 50 WG	0	+	+++	+	+++	+	Prot/ PI[1]/ AS
11	Sovran	0	+	+++	++	+++	+	Prot/ PI[1]/ AS
11&7	Pristine WG	+++	+	+++	+++	+++	+	Prot/ PI[2]/ AS[2]
17	Elevate 50 WDG	0	0	0	0	+	+++	Prot/ PI
22	Gavel 75DF	0			+++	0	0	Prot
40	Revus	0	0	0	+++	0	0	Prot/ PI/ AS
43	Presidio	0	0	0	+++	0	0	
44	Serenade ASO		0	0	0	+	++	Prot
NC	MilStop	0	0	0	0	++	0	PI/ AS/ E
U8	Vivando SC	0	0	0	0	+++	0	Prot/ PI/ AS
U	Purespray Green Spray Oil 13E	0	0	0	0	++	0	PI/ AS

0 = Ineffective; + = Slightly effective/suppression, not recommended for very susceptible varieties or at critical stages of infection; ++ = Moderately effective; +++ = Very effective; Blank cell = Information is unavailable.

Fungicide activity (adapted from NY and PA Pest Management Guidelines for Grapes):
Prot = Protective, active when present before the pathogen infects;
PI = Post-infection (pre-symptom);
AS = Anti-sporulant, reduces spore production;
E = Eradicant, kills most of fungal colony when applied after symptoms develop.

[1] Moderate post-infection activity against powdery mildew.

[2] Post-infection against powdery mildew.

NC = Not classified.

Table 6-7. Activity of Insecticides on Grape Insect Pests

Ratings in shaded cells indicate the pest is listed on the product label for control or suppression. Use insecticides only for insects listed on the product label for the crop and for the insect. Where ratings are not in shaded cells, some activity against this insect is anticipated, but this use is not on the product label. Consult the label for more information. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

Group	Product name	Grape berry moth	Leafhoppers	Phylloxera	Japanese beetle	Erineum mite	MALB	Wasps	European red mite	Climbing cutworm	Flea beetle
1A	Sevin XLR	+	++		+						
1B	Imidan 50 WP	+	+++		++						+
1B	Malathion 85 E	+	++		++		+++	+++			
3	Ambush 500 EC	+++	++								+++
3	Perm-Up	+++	++		++					+++	+++
3	Pounce 384 EC	+++	++		++					+++	+++
3	Ripcord 400 EC						+++	+++			
4	Assail 70 WP	+ at registered rate	+++	++	++						
4A	Clutch 50 WDG		+++	++							++
5	Delegate WG	+++									++
5	Entrust 80 W	++									++
5	Success 480 SC	++									++
6	Agri-Mek 1.9% EC					+			++		
11	Dipel 2X DF	++									
21	Nexter					+			++		
23	Envidor 240 SC								+++		
23	Movento 240 SC			+++							
25	Acramite 50 WS								++		
28	Altacor	+++								+++	
U	Surround WP		++		+						+
	Purespray Green Spray Oil 13E								++		
M	Kumulus DF					++					
M	Microthiol Disperss					++					

+ = Slightly effective/suppression, not recommended for very susceptible varieties or at critical stages of infection; ++ = Moderately effective; +++ = Very effective; Blank cell = Information is unavailable.

Insecticide activity adapted from NY and PA Pest Management Guidelines for Grapes , Michigan State University recommendations and other sources.

7. Tender Fruit

Tender Fruit Nutrition

Test the soil a year in advance of planting fruit trees, or two years before planting if pH adjustment may be necessary. Some soil amendments do not move readily through the soil profile, but are needed to optimize orchard productivity. These materials include organic matter, phosphorus, potassium, and lime to adjust soil pH. The only opportunity to thoroughly incorporate these materials is before planting.

Manure for Orchards

Manure can pose a food safety risk on many fruit crops. Ensure at least 120 days between manure application and harvest.

Manure contains beneficial organic matter and many macro and micronutrients. The organic nitrogen in manure is mineralized over time, providing nitrogen in diminishing quantities for years after application. Adjust additional organic and inorganic nitrogen applications accordingly. Excessive nitrogen, particularly in the second half of the growing season, can result in poor fruit colour, reduced storability, excessive growth and delayed cold-hardening of the woody tissue, which may make trees more susceptible to winter injury. Observe the following guidelines to receive the benefits of manure while minimizing potential problems:

- Apply no more than 7 tonnes/ha of poultry manure (20 m^3 liquid), 40 tonnes/ha of cattle manure (100 m^3 liquid) and 35 tonnes/ha of hog manure (65 m^3 liquid). Since the nutrient content of manure varies greatly, it should be tested before application. See *Manure nitrogen*, page 22.
- Broadcast manure and work into the soil in late fall or early spring before planting. Do not place manure around newly planted trees in late summer because of potential winter injury.
- Adjust the rate of nitrogen, phosphorus and potassium fertilizers applied according to the nutrient content of the manure. See Table 3-11. *Average Fertilizer Replacement Values for Different Types of Manure*, page 22.
- For more information about food safety and the environmental impacts of manure application, see *Manure nitrogen* and *Use manure responsibly*, page 22 and *Manure and food safety*, page 23.

pH Requirements

The pH of a soil is a measure of its acidity and affects nutrient uptake and crop performance. If the soil test report recommends a lime application to increase soil pH, add lime at recommended rates prior to planting. For details regarding rates and suggested types of lime to use, refer to *Soil pH and Liming*, page 18.

In established orchards, sample soil in the tree row every three years to ensure the pH is satisfactory. If the pH drops below 5.6 on sandy soils or below 5.1 on clay loam soils, apply lime to the sod cover in the fall or before spring cultivation. The results will not be immediate because lime moves and reacts slowly in the soil.

For details regarding suggested rates and types of lime, consult *Soil pH and Liming*, page 18.

Leaf Analysis

In established plantings, leaf analysis is the best method to determine nutrient status of the trees. When used in conjunction with soil analysis, it provides good information for adjusting fertilizer rates. For more information on these tests, see *Plant tissue analysis*, page 16.

Nutrient uptake is affected by many orchard conditions and varies slightly from year to year, depending on the season. For optimum growth and fruit quality, all nutrients must be available in sufficient concentrations. See Table 7-1. *Nutrient Concentration Sufficiency Ranges for Tender Fruits*, page 162.

For leaf analysis to be most effective, sample the same trees each year. Use leaf analysis together with soil test results to make adjustments to the fertilizer program. Fertilizer requirements are adjusted to soil management practices, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered to determine the fertilizer required. See OMAFRA document *Leaf Analyses for Fruit Crop Nutrition* at *www.ontario.ca/crops*.

Table 7-1. Nutrient Concentration Sufficiency Ranges for Tender Fruits (Mid-shoot Leaves in Late July)

Analysis	N*	P	K	Ca	Mg	Fe	B	Zn	Mn
Crop	%					Ppm			
Peach	3.4–4.1	0.15–0.4	2.3–3.5	1–2.5	0.35–0.6	25–200	20–60	15–100	20–200
Pear	2–2.6	0.15–0.4	1.2–2	1–2	0.25–0.5	25–200	20–60	15–100	20–200
Plum	2.4–3.2	0.15–0.4	1.5–3	1–2.5	0.35–0.65	25–200	20–60	15–100	20–200
Cherry (Montmorency)	2.2–3	0.15–0.4	1.3–2.5	1–2.5	0.35–0.65	25–200	20–60	15–100	20–200

* Leaf nitrogen in non-bearing trees should be 0.2% higher.

Fertilizer for Tender Fruit

Fertilizer for non-bearing tender fruit

The best time to effectively incorporate nutrients such as phosphorus, potassium, boron and lime is before planting. Adequate nutrient levels in the topsoil for orchard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium and 1,000–5,000 ppm calcium. Table 7-2. *Phosphorus and Potassium Soil Requirements Before Planting Tender Fruit Trees,* on this page, provides information on fertilizer rates prior to planting. Along with the incorporation of organic matter, these fertility levels will sustain the tree in the juvenile years. On coarse-textured, infertile soils, use a starter solution at planting time such as 10-52-10 or 20-20-20. High nitrogen levels can result in excessive growth and incomplete tree hardening. Use cover crops to reduce late season nitrogen levels in cultivated orchards, especially in new plantings. Cover crops such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil and will check tree growth. On young trees, broadcast the fertilizer under the spread of the branches. Keep the fertilizer at least 15 cm from the trunk, since injury can occur if it is placed too close.

Fertilizer for bearing tender fruit trees

Most bearing orchards require annual applications of both nitrogen and potassium fertilizer. These two elements significantly affect growth and productivity.

Nitrogen (N)

Nitrogen is necessary for many tree functions, which include growth, fruit bud formation, fruit set and fruit size. Cultivars differ in nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In situations where fruit tends to be small, more nitrogen may be needed. Rootstocks, spacing and pruning also affect nitrogen requirements. Tree growth, fruit colour and storability are also important considerations. Because of complex interactions with nitrogen and quality and production, the best guide for nitrogen rates is leaf analysis.

For pear, peach, plum and cherry orchards where leaf analysis is not available, the following rates are considered normal. For each year of the tree's age, apply between 30–40 grams of nitrogen. Thus, a five year old tree in sod culture requires 150–200 g of nitrogen. See Table 7-3. *Actual Nitrogen Rates per Tree in Sod Culture,* page 163. The rate for cultivated orchards can be reduced by half as competition for nutrients is greatly reduced. Trees on dwarfing rootstock generally require more nitrogen per ha (not per tree) than trees on more

Table 7-2. Phosphorus and Potassium Soil Requirements Before Planting Tender Fruit Trees

Soil phosphorus		Soil potassium	
New plantings of peaches, pears, plums, cherries		News plantings of peaches, pears, plums, cherries	
Soil test (ppm P)	Phosphate (P_2O_5) required (kg/ha)	Soil test (ppm K)	Potash (K_2O) required (kg/ha)
0–3	80 HR	0–15	180 HR
4–5	60 HR	16–30	170 HR
6–7	50 HR	31–45	160 HR
8–9	40 MR	46–60	140 HR
10–12	20 MR	61–80	110 HR
13–15	0 LR	81–100	70 MR
16–20	0 LR	101–120	40 MR
21–25	0 RR	121–150	20 MR
26–30	0 RR	151–180	0 LR
31–40	0 RR	181–210	0 LR
41–50	0 RR	211–250	0 RR
51–60	0 RR	250 +	0 NR
61–80	0 NR		
80 +	0 NR		

For established fruit trees, use plant analysis to estimate requirements of nitrogen, phosphorus and potassium.

HR, MR, LR, RR, and NR denote, respectively: high, medium, low, rare and no probabilities of profitable crop response to applied nutrient.

vigorous stocks. When the tree canopy has covered the space available, nitrogen fertilizer requirements level out and do not increase with tree age. Again leaf analysis is the most reliable guide. There are several forms of nitrogen available. Do not apply urea (46-0-0) to orchards with sod between the rows because urea must be incorporated to prevent loss by volatilization. For all tree fruits, do not exceed 200 kg actual nitrogen per ha per year, even in cases of severe deficiency. Late or excessive applications of nitrogen result in poor fruit colour and quality. Available nitrogen late in the season encourages the tree to grow instead of harden off, which potentially leads to winter injury. In cultivated orchards, use cover crops to help lower the nitrogen level in the latter part of the season. Cover crops such as Italian ryegrass, sown about July 1, will take up much of the available nitrogen in the soil and limit tree growth. In orchards with herbicide-treated strips under trees, allow some weed growth late in the season. Weeds take up extra nitrogen, which helps to harden off trees and improve fruit quality. If pruning is to be severe, reduce nitrogen rates or eliminate it for a year. During dry springs, irrigate to move the fertilizer into the rooting zone of the soil just before first bloom or immediately after petal fall. For fire blight-sensitive pear cultivars, use less than the maximum rate of nitrogen suggested.

Nitrogen placement and timing

Apply nitrogen fertilizer in early April. In cultivated orchards, broadcast nitrogen under the tree canopy. In sod orchards, place the nitrogen in a band under the drip line or in the herbicide strip. If there is evidence of fruit bud damage due to severe winter temperatures, it may be necessary to split nitrogen applications. Apply the first application in mid-April and the second, if necessary, after bloom in late May.

Foliar application of nitrogen

When weather or crop conditions create a need for additional nitrogen at a critical time, foliar applications of urea (46% nitrogen) have been successfully used on fruit trees. Late applications adversely affect fruit quality and winter survival of the tree.

Do not rely on foliar sprays to completely substitute for soil applications if nitrogen is required. Make applications based on tree performance and leaf analysis.

Phosphorus (P)

Phosphorus is not required in large amounts by fruit trees. With a few exceptions, the level of phosphorus in Ontario soils is adequate. Phosphorus may be required for sod or cover crop maintenance. A soil test is the best way to determine if the sod needs this nutrient.

Table 7-3. Actual Nitrogen Rates per Tree in Sod Culture

Year or tree age	Number of trees per ha (trees per ac)		
	400 (160)	500 (200)	600 (240)
	Actual nitrogen per tree (grams)		
Planting year	0	0	0
1	40	40	40
2	80	80	80
3	120	120	120
4	160	160	160
5	200	200	180
6	240	240	240
7	280	280	260
8	320	320	280
9	360	360	300
10	400	400	320
11	440	400	320
12	480	400	320

If indicated by a soil test, apply phosphorus before planting an orchard when it can be thoroughly incorporated into the soil. Phosphorus soil test values between 12–20 ppm are considered adequate for tree establishment and fruit production.

Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and resistance to disease, such as fire blight in pears. Excess potassium can lead to magnesium (Mg) deficiency, so avoid unnecessary application of potassium. Soil test values between 120–150 ppm are adequate when planting fruit trees. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available, the following rates are considered normal.

For trees one to six years of age regardless of density, apply 50 g K_2O (80 g muriate of potash) per 2.5 cm of trunk cross-section (diameter).

For trees seven years of age or older, apply no more than 3 kg of K_2O (5 kg muriate of potash) per mature standard tree in a year, regardless of how severe the deficiency. When the tree canopy has covered the space available, potassium fertilizer requirements level out and do not increase indefinitely with tree age. Leaf analysis is the most reliable guide.

Potassium placement and timing

In early spring, apply potassium separately or combined with nitrogen. Some growers make fall applications because of time constraints in the spring. Leaching during winter may cause the loss of some potassium. For this reason, apply in spring if possible. In orchards with sod between the rows, apply potash in a band around the drip line or in the herbicide strip.

Foliar application of potassium

In dry growing seasons, potassium is not readily available to the plant. Foliar application of potassium may be used where potassium deficiency is confirmed by leaf analysis.

Magnesium (Mg)

Magnesium deficiency has become more evident in orchards, particularly when high rates of potassium are used. Magnesium deficiency can lead to premature drop of fruit.

As magnesium is a part of the chlorophyll molecule, trees deficient in magnesium have older leaves that are pale in colour. Leaf analysis is the best way to evaluate magnesium needs.

Foliar sprays of magnesium are effective to correct magnesium deficiency for the current year only. For longer term correction, soil applications of magnesium are required. Magnesium soil test values between 100–250 ppm are considered adequate when planting fruit trees. See Table 7-4. *Magnesium Foliar Sprays*, page 165.

Do not mix pesticides with magnesium sulfate (Epsom salts) as foliar injury may result. Check the manufacturer's label in regard to the mixture of magnesium chelates with pesticides. Use only chelates recommended for foliar sprays. For long-term corrections, apply magnesium to the soil. The response is not immediate. On some soil types a single early spring application of soil-applied magnesium is not sufficient and a second or third application the following spring may be required before the magnesium level in the tree improves. To be sure that fruit drop is not a problem during this period, apply foliar sprays for the first two years in addition to soil applications. For soil corrections, apply 5–7 kg per mature standard tree and 3–4 kg per mature dwarf tree of sulphate of potash magnesia. This is a granular fertilizer known by several trade names. It contains approximately 21% potash and 11% magnesium. Apply in early spring in a band under the tree drip line. It contains potassium (K) and the rate of application depends on potash needs. No further potash is likely to be required, but apply nitrogen at recommended rates. Other sources of magnesium also work well as a soil application. If magnesium is being blended with the fertilizer, apply at least 80 kg of available magnesium per ha when the fertilizer is spread. Use dolomitic limestone on acidic soils to raise the soil pH and to supply magnesium.

Calcium (Ca)

Lack of calcium is associated with fruit quality problems in pear and gummosis in European plums and prunes. Calcium sprays must contact the fruit for uptake to be effective; therefore water volumes capable of wetting the entire tree are required. Some formulations of calcium chloride ($CaCl_2$) result in poor fruit finish if applied too close to harvest. Excessive calcium can cause foliar damage. The product used is not as important as the total amount of actual (elemental) calcium applied.

Use $CaCl_2$ (77% flakes) at 4 kg/1,000 L of water from early July to mid-August. Apply three sprays, 10–12 days apart. For acceptable results up to 12 kg/ha of actual calcium is often required in a total of four or more sprays. Calcium sprays may injure foliage and fruit if applied during low temperatures and wet weather. These conditions delay the drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather. Do not apply calcium formulations containing nitrogen after the end of July or fruit quality and storability may suffer. For all formulations, consult the label for rates and compatibility with pesticides.

Micronutrients for Tender Fruit

Deficiencies of micronutrients or trace elements are not widespread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. Micronutrients applied in excess can cause more damage than deficiencies. Leaf analysis is more effective than soil analysis to evaluate tree micronutrient status. For more information see *Micronutrients*, page 26.

- Do not apply micronutrients to fruit crops unless leaf analysis confirms a deficiency.

- Apply only the nutrient that is deficient and only in sufficient quantities to correct the problem.

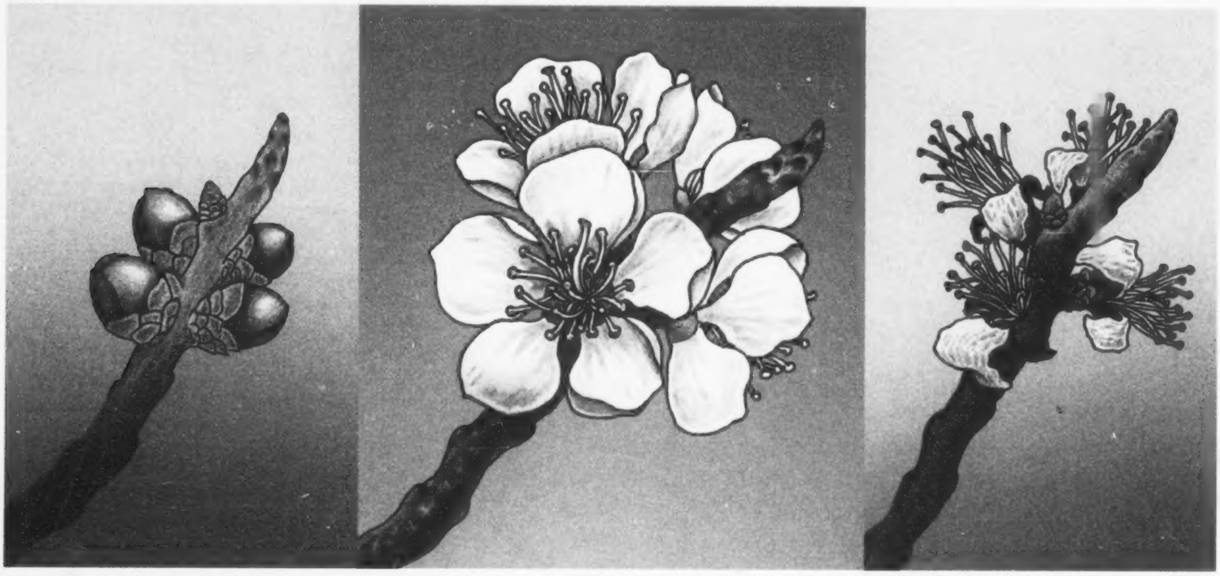
Apply nutrient sprays according to recommended rates on the product label. Do not spray during temperatures above 25°C.

Table 7-4. Magnesium Foliar Sprays

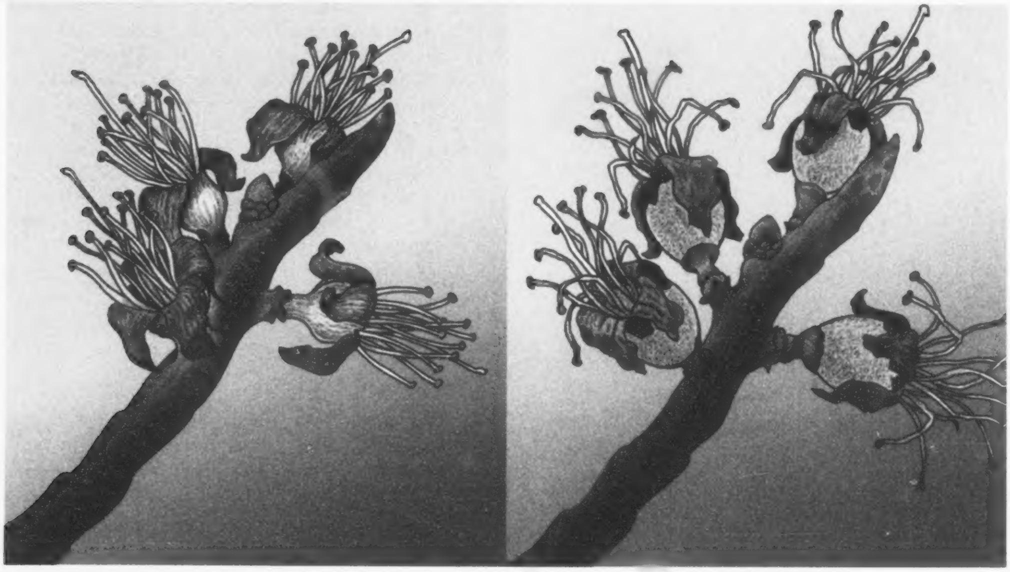
Timing	Product	Rate	Notes
3 sprays spaced 2 weeks apart beginning at petal fall/shuck or shuck split	Magnesium sulfate (Epsom salts)	20 kg/1,000 L water	Wet tree to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use only chelates recommended for foliar sprays.

Figure 7-1. Apricot Growth Stages



Dormant Bloom Petal Fall



Shuck Shuck Split

Apricot Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

Products are listed by fungicide and insecticide group. Use products from different groups to prevent pest resistance. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-5. *Products Used on Apricots,* page 170.

Diseases and Insects	Products	Rate	Comments
Dormant (in late March or early April before buds swell)			
European red mite	• Superior 70 Oil • Purespray Green Spray Oil 13 E	20 L/1,000 L water 20 L/1,000 L water	Apply in a high volume spray to ensure thorough coverage. Do not apply Captan or Maestro within 14 days of oil.
Bloom			
DO NOT APPLY INSECTICIDES WHILE APRICOT TREES ARE IN BLOOM. SEE *BEE POISONING,* ON PAGE 267.			
Blossom blight stage of brown rot	• Rovral • Topas or Jade or Mission 418 EC • Indar 75 WSP • Vangard 75 WG • Lance WDG or Cantus WDG • Pristine WG • Supra Captan 80 WDG or Maestro 80 DF	1.5 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 370 g/ha 370 g/ha 370 g/ha 750 g/ha 4.5 kg/ha 4.5 kg/ha	Apricots are extremely susceptible to brown rot. Spray when first blossoms open. If wet weather occurs repeat spray at 50% bloom and at full bloom. To avoid resistance, alternate among fungicide groups and do not use products from the same group in consecutive sprays. **Rovral, Topas, Jade, Mission, Indar, Vangard, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides,* page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action,* page 257. These products are locally systemic. Consult labels for information on drying time required before rain. **Topas, Mission, Jade, Indar:** Do not rotate Topas, Mission, Jade and Indar. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus.
Petal fall			
Brown rot	• Rovral • Topas or Jade or Mission 418 EC • Indar 75 WSP • Vangard 75 WG • Lance WDG or Cantus WDG • Pristine WG • Supra Captan 80 WDG or Maestro 80 DF	1.5 kg/ha 500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 370 g/ha 370 g/ha 370 g/ha 750 g/ha 4.5 kg/ha 4.5 kg/ha	Apricots are extremely susceptible to brown rot. Spray when first blossoms open. If wet weather occurs repeat spray at 50% bloom and at full bloom. To avoid resistance, alternate among fungicide groups and do not use products from the same group in consecutive sprays. **Rovral, Topas, Jade, Mission, Indar, Vangard, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides,* page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action,* page 257. These products are locally systemic. Consult labels for information on drying time required before rain. **Topas, Mission, Jade, Indar:** Do not rotate Topas, Mission, Jade and Indar. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus.

Diseases and Insects	Products	Rate	Comments
Oriental fruit moth (OFM)	• Isomate-M Rosso • Isomate-M 100	500 dispensers/ha 250 dispensers/ha	Pheromone mating disruption products are not insecticides and will not control other pests that may be present. Use mating disruption only if initial OFM population is low. Apply to square or rectangular orchard blocks at least 4 ha in size. This technology may be used in apricot orchards that are less than 4 ha but are adjacent to orchards of sufficient size, if both are using this technology. Apply dispensers before OFM flight begins. For more information see *Using mating disruption to control oriental fruit moth (Isomate-M Rosso and Isomate-M 100)*, page 249 and OMAFRA Factsheet *Mating Disruption for Management of Oriental Fruit Moth in Stone and Pome Fruit*, Order No. 04-029. **Isomate-M 100:** Make a second application 75–80 days after initial application if necessary. **Isomate-M Rosso:** Provides mating disruption for up to 120 days. If desired, use both an insecticide and mating disruption for managing first generation OFM (see **Shuck split**).
Shuck split (when about 50% of shucks have split)			
Brown rot	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Rovral • Vangard 75 WG • Lance WDG or Cantus WDG • Pristine WG • Supra Captan 80 WDG or Maestro 80 DF	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 1.5 kg/ha 370 g/ha 370 g/ha 370 g/ha 750 g/ha 4.5 kg/ha 4.5 kg/ha	Apricots are extremely susceptible to brown rot from bloom through pit-hardening. **Rovral, Topas, Mission, Jade, Indar, Vangard, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. These products are locally systemic. Consult labels for information on drying time required before rain. **Topas, Mission, Jade, Indar:** Do not rotate among these products. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus.
Oriental fruit moth (OFM)	• Assail 70 WP • Rimon 10 EC • Altacor • Delegate WG	120–240 g/ha 1.35–3.35 L/ha 285 g/ha 420 g/ha	Products are recommended at different timings because they work best on specific life stages of the pest. Apply within the appropriate degree-days specified for best results. **Altacor, Delegate, Assail, Rimon:** Apply at first egg hatch 80–120 degree-days (base 7.2°C) after first sustained moth catch in pheromone traps. **Assail:** For optimum activity, use the 240 g/ha rate. Apply in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Also controls plum curculio. **Altacor:** Do not exceed 645 g/ha per year. For resistance management, if more than one spray is required for this generation, use a product from the same chemical group. For subsequent generations, rotate to another group.
Plum curculio	• Assail 70 WP • Clutch 50 WDG • Sevin XLR	240 g/ha 210 g/ha 6.25 L/ha	Apricots are very susceptible to plum curculio injury. Scout edges of orchards near woodlots and wild hosts in spring. Check small fruit for crescent-shaped egg-laying scars. Damage often occurs only on the border of the orchard. Check developing fruit for new damage 7–10 days after insecticide is applied. **Assail:** Under high insect pressure, the level of damage reduction may be limited to suppression rather than control. **Clutch:** If applied at the appropriate timing and at 420 g/ha, Clutch may provide suppression of oriental fruit moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control.

Diseases and Insects	Products	Rate	Comments
Shuck fall (10–12 days after last spray)			
Brown rot	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Lance WDG or Cantus WDG • Pristine WG • Vangard 75 WG • Supra Captan 80 WDG or Maestro 80 DF	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 370 g/ha 370 g/ha 750 g/ha 370 g/ha 4.5 kg/ha 4.5 kg/ha	Apricots are extremely susceptible to brown rot from bloom through pit-hardening. **Topas, Mission, Jade, Indar, Vangard, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. These products are locally systemic. Consult labels for information on drying time required before rain. **Topas, Jade, Mission, Indar:** Do not rotate among these fungicides. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus.
Plum curculio	• Assail 70 WP • Clutch 50 WDG • Sevin XLR	240 g/ha 210 g/ha 6.25 L/ha	Monitor for plum curculio damage and spray if fresh damage is found. **Assail:** Under high insect pressure, may provide suppression rather than control of plum curculio. **Clutch:** If applied at the appropriate timing and at 420 g/ha, Clutch may provide suppression of oriental fruit moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control.
Lesser peachtree borer Peachtree borer	• Thionex 50 W • Sevin XLR	1.5 kg/1,000 L water 6.25 L/ha	Peachtree borers are sporadic pests of apricots. In areas with high borer populations, use the following spray regime. Use pheromone traps to monitor adult activity and begin sprays one week after first flight. Make three applications at 5–10 day intervals. Direct these sprays with a handgun to cover trunk and scaffold limbs thoroughly; do not spray fruit. Sevin is registered only for lesser peachtree borer. See Table 7-5. *Products Used On Apricots*, page 170 for preharvest intervals.
First cover (10–12 days after Shuck fall)			
Brown rot	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Lance WDG or Cantus WDG • Pristine WG • Vangard 75 WG • Supra Captan 80 WDG or Maestro 80 DF	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 370 g/ha 370 g/ha 750 g/ha 370 g/ha 4.5 kg/ha 4.5 kg/ha	Apricots are extremely susceptible to brown rot from bloom through pit-hardening. **Topas, Mission, Jade, Indar, Vangard, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2, *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. These products are locally systemic. Consult labels for information on drying time required before rain. **Topas, Jade, Mission, Indar:** Do not rotate among these fungicides. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus.
Plum curculio	Use one of the insecticides listed for plum curculio at **Shuck split.**		
Special sprays (when monitoring indicates the need)			
European red mite	• Envidor 240 SC	750 mL/ha	European red mite is a sporadic pest and is rarely a problem in apricot orchards. Apply when red mites build up to 10 active stages per leaf in the absence of beneficial predatory mites. **Envidor:** Works slowly, especially in cool weather. Control may not be apparent for 2–3 weeks. Apply before mite populations build up. Maximum one application per season.

Diseases and Insects	Products	Rate	Comments
Oriental fruit moth (OFM)	• Altacor • Delegate WG • Assail 70 WP • Rimon 10 EC	285 g/ha 420 g/ha 120–240 g/ha 1.35–3.35 L/ha	**Rimon:** Apply before peak egg-laying, 555-583 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). **Assail:** Apply before first egg hatch, 583-611 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). For optimum activity, use the 240 g/ha rate. Apply in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Will also control plum curculio. **Altacor, Delegate:** Apply at first egg hatch, 640-670 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). Monitor populations and re-apply 10–14 days later if required. **Altacor:** Do not exceed 645 g/ha per year. For resistance management, if more than one spray is required for this generation, use a product from the same chemical group. For subsequent generations, rotate to another chemical group.
Obliquebanded leafroller (OBLR) Leafrollers	• Altacor • Delegate WG • Success 480 SC or Entrust 80 W • Rimon 10 EC • Dipel 2X DF or Bioprotec CAF	285 g/ha 420 g/ha 182 mL/ha 109 g/ha 1.35–3.35 L/ha 1.125 kg/ha 4 L/ha	Insecticides for OBLR summer generation should be applied at 240–280 degree-days C (base 6.1°C) after biofix (first sustained moth catch). **Altacor:** Do not exceed 645 g/ha per year. **B.t. products (Dipel, Bioprotec):** Make two applications at 5–7 day intervals if activity of the larvae is extended. B.t. products work best if applied in the evening or on a cloudy day. See *Biopesticides for Insect Control,* page 247. For resistance management, if more than one spray is required for this generation, use a product from the same chemical group. For subsequent generations, rotate to another chemical group.
Prepick to harvest			
Check preharvest interval before spraying early maturing varieties. See Table 7-5. *Products Used on Apricots,* page 170.			
Brown rot	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Vangard 75 WG • Lance WDG or Cantus WDG • Pristine WG • Supra Captan 80 WDG or Maestro 80 DF	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 740 g/ha 370 g/ha 370 g/ha 750 g/ha 4.5 kg/ha 4.5 kg/ha	Apricots are extremely susceptible to brown rot just before picking. **Topas, Jade, Mission:** No more than two applications in the three weeks prior to harvest.
Postharvest fruit treatment			
Blue mould Grey mould Brown rot Rhizopus rot	• Scholar 230 SC	496 mL/378 L of water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions.

Table 7-5. Products Used on Apricots

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	**Registration number**	**Common name**	**Group**	**Preharvest interval**	**Minimum re-entry**	**Maximum number of applications per year (on label)**
Products used for control or suppression of insects and mites						
Altacor	28981	chlorantraniliprole	28	10 days	12 hours	3
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours/6 days[1]	4
Bioprotec CAF	26854	*Bacillus thuringiensis*	11	1 day		
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2
Delegate WG	28778	spinetoram	5	14 days	12 hours	3
Dipel 2X DF	26508	*Bacillus thuringiensis*	11	1 day		
Entrust 80 W	27825	spinosad	5	14 days		3
Envidor 240 SC	28051	spirodiclofen	23	7 days	12 hours	1
Purespray Green Spray Oil 13E	27666	mineral oil			12 hours	
Rimon 10 EC	28881	novaluron	15	14 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	5 days		
Success 480 SC	26835	spinosad	5	14 days		3
Superior 70 Oil	9542 14981	mineral oil		prebloom only	12 hours	
Thionex 50 W	14617	endosulfan	2A	18 days	7 days/20 days[1]	3
Products used for control or suppression of diseases						
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Indar 75 WSP	27294	fenbuconazole	3	1 day	12 hours	7
Jade	24030	propiconazole	3	3 days	72 hours	5[2]
Lance WDG	27495	boscalid	7	0 days	12 hours	5
Maestro 80 DF	26408	captan	M	2 days	48 hours	
Mission 418 EC	28016	propiconazole	3	3 days	72 hours	5[2]
Pristine WG	27985	pyraclostrobin + boscalid	11+7	0 days	24 hours/10 days[3]	5
Rovral	15213	iprodione	2	1 day	12 hours	
Scholar 230 SC	29528	fludioxonil	12	postharvest		
Supra Captan 80 WDG	24613	captan	M	2 days	48 hours	
Topas	30163	propiconazole	3	3 days	72 hours	5[2]
Vangard 75 WG	25509	cyprodinil	9	2 days	72 hours	4

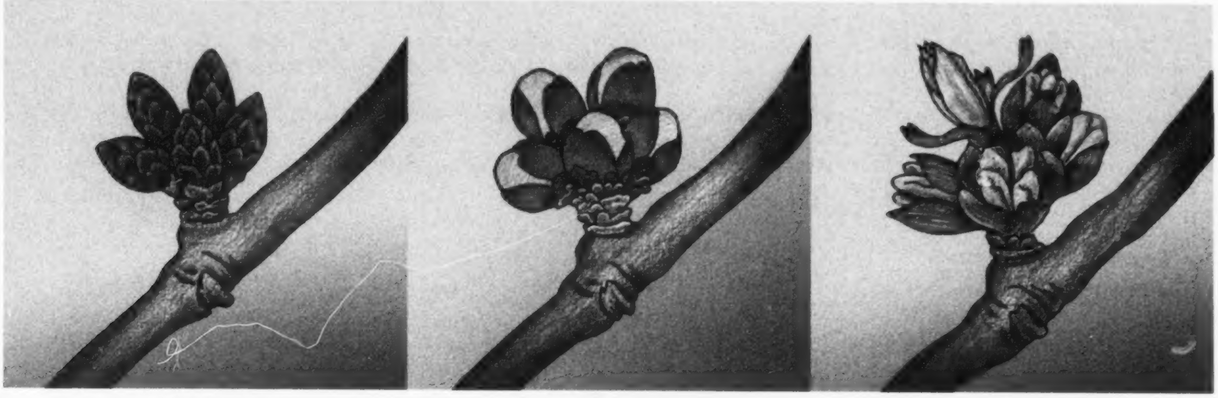
A blank cell indicates the information is not specified on the product label.

[1] Re-entry period/exceptions are as follows: re-entry/hand thinning.

[2] No more than two applications in the 3 weeks prior to harvest.

[3] Re-entry period/exceptions are as follows: 24 hours for hand harvest/10 days for hand thinning, otherwise when dry.

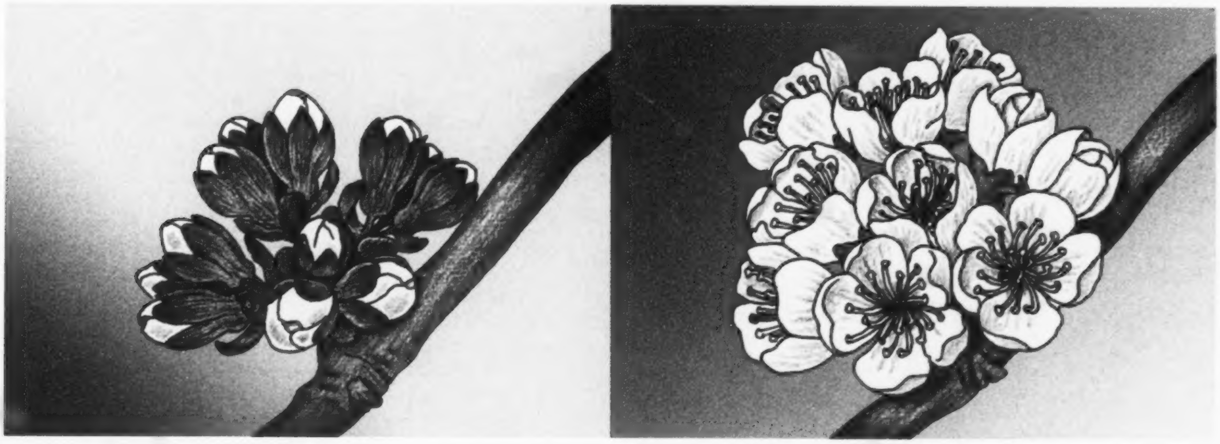
Figure 7-2. Sour and Sweet Cherry Growth Stages



Dormant

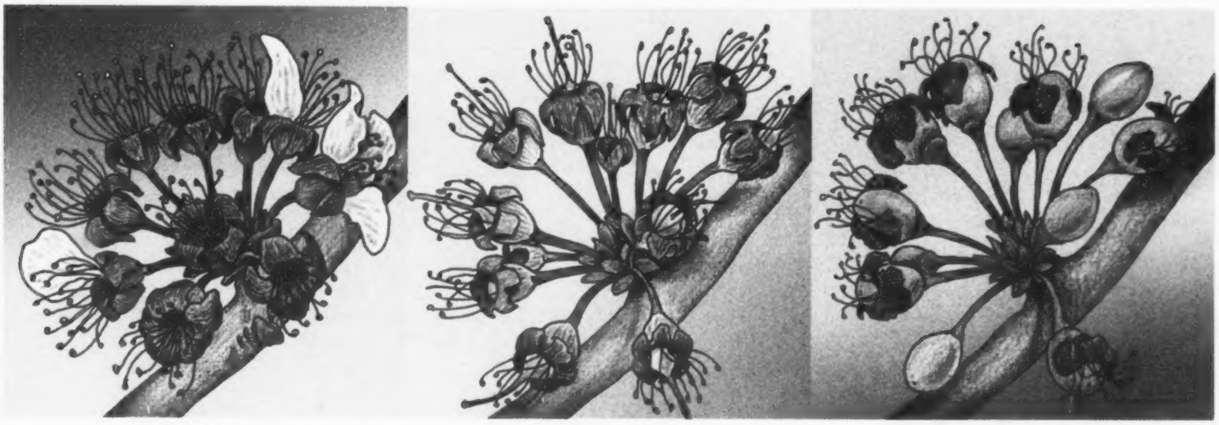
Delayed Dormant

Prebloom



White Bud

Bloom



Petal Fall

Shuck

Shuck Split

Sour Cherry Calendar

Read the product label and follow all safety precautions. Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

Products are grouped by fungicide and insecticide family. Use products from different groups to prevent pest resistance. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-6. *Products Used on Sour Cherries,* page 176.

Diseases and Insects	**Products**	**Rate**	**Comments**
Dormant (before bud break)			
Bacteria canker	• Copper Spray • Guardsman Copper Oxychloride	6–9 kg/1,000 L water 6–9 kg/1,000 L water	Apply in early spring before bud break. Later applications may cause injury. Use low rate on small trees and high rate on large trees.
Black knot	Prune out, remove and burn all black knots from commercial orchards during dormant period before bud break. Remove any wild infected cherry hosts surrounding commercial orchards. See OMAFRA Factsheet *Black Knot of Plums,* Order No. 05-017, for more information.		
Prebloom			
European red mite	• Superior 70 Oil • Purespray Green Spray Oil 13E	20 L/1,000 L water 20 L/1,000 L water	Needed only in sour cherry orchards with a history of heavy mite populations. Spray as buds are breaking. Mature trees require water volumes of approximately 3,000 L/ha for thorough coverage.
Bloom			
DO NOT APPLY INSECTICIDES WHILE CHERRY TREES ARE IN BLOOM. SEE *BEE POISONING* ON PAGE 267.			
Blossom blight stage of brown rot	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Funginex DC • Nova 40 W • Rovral • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG • Bravo 500 or Echo 720 • Supra Captan 80 WDG or Maestro 80 DF • Kumulus DF or Microthiol Disperss	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 2.5 L/ha 340 g/ha 1.5 kg/ha 1.7 kg/ha 370 g/ha 370 g/ha 750 g/ha 7 L/ha 3.5–6.3 L/ha 4.5 kg/ha 4.5 kg/ha 22.5 kg/ha 22.5 kg/ha	Spray when first blooms open if weather conditions are expected to be wet and warm (above 16°C) during bloom. Sour cherries are less susceptible to brown rot than sweet cherries. One application during bloom should be sufficient, unless frequent wet periods occur and brown rot pressure is high. See *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253. **Rovral, Topas, Jade, Mission, Indar, Vangard, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides,* page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action,* page 257. These products are locally systemic. Consult labels for information on drying time required before rain. **Nova, Funginex, Topas, Jade, Mission, Indar:** Do not rotate among these products. **Topas, Jade, Mission:** Also suppress black knot. **Pristine, Lance, Cantus:** Do not alternate Pristine with Lance or Cantus. **Bravo, Echo:** Make 1–3 applications from white bud through shuck split. Use higher rate for trees greater than 6 m in height or if weather is warm (above 16°C) and wet during bloom. **Captan, Maestro, Bravo, Echo:** Do not use within 14 days of an oil application.

Diseases and Insects	Products	Rate	Comments
Petal fall			
Leaf spot	• Bravo 500 or Echo 720 • Supra Captan 80 WDG or Maestro 80 DF • Nova 40 W • Topas or Jade or Mission 418 EC • Pristine WG • Flint 50 WG • Ferbam 76 WDG • Equal 65 WP	7 L/ha 3.5–6.3 L/ha 4.5 kg/ha 4.5 kg/ha 340 g/ha 500 mL/ha 500 mL/ha 300 mL/ha 750 g/ha 210 g/ha 1.75–2 kg/1,000 L water 2.25 kg /ha	Spray only if rain is forecast between **Bloom** and **Shuck split** sprays. Alternate fungicides from different chemical groups. **Bravo, Echo:** Make one application to control early season leaf spot. **Flint and Pristine:** Do not rotate Pristine with Flint. **Flint:** Do not apply where spray drift may reach Concord grapes as it may cause crop injury. **Nova, Topas, Jade, Mission:** Do not rotate among these products.
Black knot	• Bravo 500 or Echo 720 • Indar 75 WSP • Topas or Jade or Mission 418 EC	7 L/ha 4.2–6.3 L/ha 140 g/ha 500 mL/ha 500 mL/ha 300 mL/ha	This spray is only needed on sour cherry orchards with a history of black knot. **Topas, Jade, Mission:** Provide suppression rather than control of black knot. Refer to label. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control.
Shuck split			
Plum curculio	• Assail 70 WP • Clutch 50 WDG • Imidan 50 WP	240 g/ha 210 g/ha 3.75 kg/ha	Spray when most shucks are off and plum curculio activity is observed. **Assail:** Under high insect pressure, may provide suppression rather than control of plum curculio. **Clutch:** If applied at the appropriate timing and at 420 g/ha, Clutch may provide suppression of oriental fruit moth.
Brown rot	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Rovral • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG • Bravo 500 or Echo 720 • Supra Captan 80 WDG or Maestro 80 DF	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 1.5 kg/ha 1.7 kg/ha 370 g/ha 370 g/ha 750 g/ha 7 L/ha 3.5–6.31 L/ha 4.5 kg/ha 4.5 kg/ha	Do not use products from the same group in consecutive sprays. **Topas, Jade, Mission, Indar:** Do not rotate among these products. **Topas, Jade, Mission:** No more than two applications in the three weeks prior to harvest. These products also suppress black knot. **Pristine, Lance, Cantus:** Do not alternate Pristine with Lance or Cantus. **Bravo, Echo:** Do not apply after shuck split to avoid fruit injury. **Echo 720:** Make 1–3 applications from white bud through shuck split. Use higher rate for trees greater than 6 m in height or if weather is warm (above 16°C) and wet during bloom.
Leaf spot	Use one of the fungicides recommended at **Petal fall** with the exception of Ferbam. Do not apply Bravo or Echo after shuck split to avoid fruit injury.		
European red mite	• Nexter	300 g/ha	Thorough coverage is necessary for good mite control. Only needed in heavily infested sour cherry orchards.
Black knot	• Bravo 500 or Echo 720 • Indar 75 WSP • Topas or Jade or Mission 418 EC	7 L/ha 4.2–6.3 L/ha 140 g/ha 500 mL/ha 500 mL/ha 300 mL/ha	This spray is needed only in sour cherry orchards with a history of black knot. Spore release may be delayed in dry springs. Under these conditions, extend fungicide coverage to first cover. See OMAFRA Factsheet *Black Knot of Plums*, Order No. 05-017, for more information. **Bravo, Echo:** Do not apply after shuck split to avoid fruit injury. **Topas, Jade, Mission:** Provide suppression rather than control of black knot.

Diseases and Insects	Products	Rate	Comments
First cover (12 days after shuck split)			
Plum curculio	Use one of the insecticides listed under **Shuck.**		Monitor 7 days after the insecticide at **Shuck split** for new plum curculio damage. If new crescent-shaped cuts on fruit are found, apply an insecticide.
Powdery mildew	• Nova 40 W • Flint 50 WG • Cabrio EG • Pristine WG • Quintec • Kumulus DF or Microthiol Disperss	340 g/ha 210 g/ha 670 g/ha 750 g/ha 500 mL/ha 12 kg/ha 12 kg/ha	Cover sprays applied after shuck split are critical for powdery mildew control. Do not use products from the same group in consecutive sprays. **Flint, Cabrio, Pristine:** Do not rotate among these products. **Flint:** Do not apply where spray drift may reach Concord grapes as it may cause crop injury. **Quintec:** Apply when conditions favour disease or at first signs of mildew on foliage. Apply no more than two times before rotating to another fungicide family for mildew control.
Obliquebanded leafroller (OBLR)	• Dipel 2X DF or Bioprotec CAF • Success 480 SC or Entrust 80 W • Delegate WG • Altacor • Rimon 10 EC	1.12 kg/ha 4 L/ha 182 mL/ha 109 g/ha 420 g/ha 285 g/ha 2.35–3.35 L/ha	Routine monitoring is necessary to determine if OBLR is causing damage in sour cherries. **Delegate, Altacor, Rimon:** For OBLR summer generation, apply at 240–280 degree-days C (base 6.1°C) after biofix. For resistance management, if more than one spray is required for this generation, use a product from the same chemical group. For subsequent generations, rotate to another chemical group. **Dipel, Bioprotec:** See *Biopesticides for Insect Control*, page 247.
Leaf spot	Use one of the fungicides listed under **Petal fall** with the exception of Ferbam and Bravo or Echo.		
Special sprays (when monitoring indicates the need)			
European red mite	• Envidor 240 SC	750 mL/ha	**Envidor:** Works slowly, especially in cool weather. Control may not be apparent for 2–3 weeks. Apply before mite populations build up.
Second cover (12 days after First cover)			
Cherry fruit fly	• GF-120 NF • Entrust 80 W • Admire 240 F • Assail 70 WP • Imidan 50 WP • Diazinon 50 WSP	1.5 L/ha 109 g/ha 233 mL/ha 240 g/ha 3.75 kg/ha 1 kg/1,000 L water	**GF-120:** Spray as soon as monitoring traps indicate flies are present or 2–3 weeks before ripening. GF-120 is a bait formulation that requires large droplet size (4–6 mm); specialized application equipment may be needed. GF-120 will lose effectiveness if exposed to rain or overhead irrigation. **Diazinon, Imidan:** On early varieties, check preharvest interval. Spray when early varieties are beginning to colour. **Diazinon:** Provides 10 days protection against cherry fruit fly.
Plum curculio	• Assail 70 WP • Clutch 50 WDG • Imidan 50 WP	240 g/ha 210 g/ha 3.75 kg/ha	**Assail:** Under high insect pressure, may provide suppression rather than control of plum curculio. **Imidan:** Check preharvest interval. See Table 7-6. *Products Used on Sour Cherries*, page 176.
Obliquebanded leafroller	Routine monitoring is necessary to determine if obliquebanded leafrollers are causing damage in sour cherries. Use one of the products listed for obliquebanded leafroller at **First cover**.		
Leaf spot	Use one of the fungicides recommended at **Petal fall** with the exception of Ferbam and Bravo or Echo.		
Powdery mildew	• Nova 40 W • Cabrio EG • Pristine WG • Flint 50 WG • Quintec • Kumulus DF or Microthiol Disperss	340 g/ha 670 g/ha 750 g/ha 210 g/ha 500 mL/ha 12 kg/ha 12 kg/ha	Do not use products from the same group in consecutive sprays. **Cabrio, Pristine, Flint:** Do not rotate among these products. **Flint:** Do not apply where spray drift may reach Concord grapes as it may cause crop injury. **Cabrio:** Will also suppress brown rot. **Pristine:** Provides suppression of powdery mildew. **Quintec:** Apply when conditions favour disease or at first signs of mildew on foliage. Apply no more than two times before rotating to another fungicide group for mildew control. **Kumulus, Microthiol:** Suppress powdery mildew at this rate. Higher rates may cause injury. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control.

Diseases and Insects	Products	Rate	Comments
Third cover			
Check preharvest interval before spraying early maturing cherries. See Table 7-6. *Products Used on Sour Cherries*, page 176.			
Cherry fruit fly	• GF-120 NF • Entrust 80 W • Admire 240 F • Assail 70 WP • Imidan 50 WP • Diazinon 50 WSP • Sevin XLR	1.5 L/ha 109 g/ha 233 mL/ha 240 g/ha 3.75 kg/ha 1 kg/1,000 L water 6.25 L/ha	**GF-120:** Spray as soon as monitoring traps indicate flies are present or 2–3 weeks before ripening. GF-120 is a bait formulation that requires large droplet size (4–6 mm): specialized application equipment may be needed. GF-120 will lose effectiveness if exposed to rain or overhead irrigation. **Admire:** Monitor for cherry fruit fly and apply as a foliar spray within 6 days of first fly emergence. Thorough coverage is necessary for optimal control. Allow at least 10 days between applications. **Assail :** Provides suppression of cherry fruit fly. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. **Sevin, Imidan, Diazinon:** Spray sour cherries about the time Montmorency is turning pink. **Sevin:** Provides 5–7 days protection.
Brown rot	Use one of the fungicides recommended at **Shuck split.**		
Leaf spot	Use one of the fungicides listed under **Petal fall** with the exception of Ferbam, Bravo and Echo.		
Special sprays (when monitoring indicates the need)			
European red mite	• Envidor 240 SC	750 mL/ha	**Envidor:** Works slowly, especially in cool weather. Control may not be apparent for 2–3 weeks. Apply before mite populations build up.
Preharvest			
Check preharvest interval before spraying early maturing cherries. See Table 7-6. *Products Used on Sour Cherries*, page 176.			
Brown rot	Use one of the fungicides recommended at **Shuck split.**		
Postharvest			
Leaf spot	• Bravo 500 or Echo 720 • Supra Captan 80 WDG or Maestro 80 DF • Nova 40 W • Equal 65 WP • Pristine WG • Flint 50 WG	7 L/ha 3.5–6.3 L/ha 4.5 kg/ha 4.5 kg/ha 340 g/ha 2.25 kg/ha 750 g/ha 210 g/ha	Necessary where leaf spot is a problem. **Pristine and Flint:** Do not rotate between these products. **Flint:** Do not apply where spray drift may reach Concord grapes as it may cause crop injury. **Bravo, Echo:** Apply once to foliage 1–7 days after fruit is removed; in orchards with high leaf spot incidence, make a second application 10–14 days later.
Powdery mildew	• Cabrio EG • Pristine WG • Quintec	670 g/ha 750 g/ha 500 mL/ha	**Pristine and Cabrio:** Do not rotate Pristine with Cabrio. **Pristine:** Provides suppression rather than control of powdery mildew. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control.
Special sprays (when monitoring indicates the need)			
Aphids	• Movento 240 SC • Diazinon 50 WSP • Clutch 50 WDG • Beleaf 50 SG • Thionex 50 W	365 mL/ha 1 kg/1,000 L water 210 g/ha 120–160 g/ha 3.25 kg/ha	These may be added to a compatible fungicide after bloom. Thorough coverage and a calm, warm day are necessary for good aphid control. **Movento:** Most effective on young stages of aphids. Has slow activity; control may not be apparent for 2–3 weeks. Under high aphid pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. **Diazinon:** Registered for black cherry aphid only. **Beleaf:** Use higher rate for greater pest populations and/or dense foliage.

Diseases and Insects	Products	Rate	Comments
Peachtree borer Lesser peachtree borer	• Thionex 50 W • Sevin XLR	1.5 kg/1,000 L water 6.25 L/ha	Apply first spray 7 days after first adult catch in pheromone traps. Spray up to three times if needed, at weekly intervals. Direct these sprays with a handgun to cover the trunk and scaffold limbs thoroughly. Check preharvest intervals, especially for the second and third sprays and do not apply if the fruit is to be harvested during this period. Sevin XLR is not registered for peachtree borer.
Postharvest fruit treatment			
Blue mould Grey mould Brown rot Rhizopus rot	• Scholar 230 SC • Bio-Save 10 LP	496 mL/378 L water 50 g/100 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions. **Bio-Save:** Labelled for blue mould and grey mould only. Provides suppression rather than control of these storage rots. See *Pseudomonas syringae* (Bio-Save 10 LP), page 243, and Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control.
Fall spray			
Bacterial canker	• Copper Spray • Guardsman Copper Oxychloride		Apply when three-quarters of leaves have fallen.

Table 7-6. Products Used on Sour Cherries

Use this table as a guide but refer to product label for specific information.

The **preharvest** interval is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used for control or suppression of insects and mites						
Admire 240 F	24094	imidacloprid	4	10 days	24 hours	5
Altacor	28981	chlorantraniliprole	28	10 days	12 hours	3
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours/6 days[3]	4
Beleaf 50 SG	29796	flonicamid	9	14 days	12 hours/ 48 hours[3]	3
Bioprotec CAF	26854	*Bacillus thuringiensis*	11	1 day		
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2
Delegate WG	28778	spinetoram	5	7 days	12 hours	3
Diazinon 50 WSP	29976	diazinon	1B	10 days	4 days	
Dipel 2X DF	26508	*Bacillus thuringiensis*	11	1 day		
Entrust 80 W	27825	spinosad	5	7 days		4
Envidor 240 SC	28051	spirodiclofen	23	7 days	12 hours	1
GF-120 NF	28336	spinosad	5	0 days		10
Imidan 50 WP	23006	phosmet	1B	7 days	3 days/14 days[1]	4
Movento 240 SC	28593	spirotetramat	23	7 days	12 hours	

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period/exceptions are as follows: no re-entry/unless with protective clothing. See label.

[2] Before shuck fall.

[3] Re-entry period/exceptions are as follows: re-entry/ hand thinning and pruning.

[4] Depends on rate, see label.

[5] No more than two applications of this fungicide group in the 3 weeks prior to harvest.

[6] Re-entry period/exceptions are as follows: 24 hours for hand harvest/10 days for hand thinning, otherwise when dry.

[7] 1 application with airblast or 3 with hand-held equipment.

Table 7-6. Products Used on Sour Cherries (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Nexter	25135	pyridaben	21	7 days	24 hours	1
Purespray Green Spray Oil 13E	27666	mineral oil		Apply prebloom	12 hours	
Rimon 10 EC	28881	novaluron	15	14 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	2 days		
Success 480 SC	26835	spinosad	5	7 days		3
Superior 70 Oil	9542	mineral oil		apply prebloom	12 hours	
Thionex 50 W	14617	endosulfan	2A	18 days	7 days/20 days[1]	1/3[7]
Products used for control or suppression of diseases						
Bio-Save 10 LP	29673	*Pseudomonas syringae* Strain ESC-10		use postharvest		
Bravo 500	15723	chlorothalonil	M	40 days	48 hours	3[2]
Cabrio EG	27323	pyraclostrobin	11	10 days	12 hours/9 days[3]	5
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Copper Spray	19146	copper oxychloride	M		48 hours	
Echo 720	29355	chlorothalonil	M	40 days	48 hours	3[2]
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Equal 65 WP	15608	dodine	M	7 days	48 hours	2[4]
Ferbam 76 WDG	20136	ferbam	M	4 days		
Flint 50 WG	27529	trifloxystrobin	11	1 day	12 hours	2
Funginex DC	27686	triforine	3	do not apply after bloom	48 hours	3
Guardsman Copper Oxychloride	13245	copper oxychloride	M		48 hours	
Indar 75 WSP	27294	fenbuconazole	3	1 day	12 hours	7
Jade	24030	propiconazole	3	3 days	72 hours	5[5]
Kumulus DF	18836	sulphur	M	1 day	24 hours	
Lance WDG	27495	boscalid	7	0 days	12 hours	5
Maestro 80 DF	26408	captan	M	5 days	48 hours	
Microthiol Disperss	29487	sulphur	M	1 day	24 hours	8
Mission 418 EC	28016	propiconazole	3	3 days	72 hours	5[5]
Nova 40 W	22399	myclobutanil	3	1 day		
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days	24 hours/ 10 days[6]	5
Quintec	29755	quinoxyfen	13	7 days	12 hours	5
Rovral	15213	iprodione	2	1 day	12 hours	
Scholar 230 SC	29528	fludioxonil	12	use postharvest		1
Supra Captan 80 WDG	24613	captan	M	5 days	48 hours	
Topas	30163	propiconazole	3	3 days	72 hours	5[5]

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period/exceptions are as follows: no re-entry/unless with protective clothing. See label.

[2] Before shuck fall.

[3] Re-entry period/exceptions are as follows: re-entry/ hand thinning and pruning.

[4] Depends on rate, see label.

[5] No more than two applications of this fungicide group in the 3 weeks prior to harvest.

[6] Re-entry period/exceptions are as follows: 24 hours for hand harvest/10 days for hand thinning, otherwise when dry.

[7] 1 application with airblast or 3 with hand-held equipment.

Growth Regulators for Sour Cherries

Ethephon (Ethrel) to promote fruit loosening of sour cherries at harvest

Ethephon (Ethrel) can be used in sour cherry orchards to promote fruit loosening, uniform maturity and to facilitate mechanical harvest.

The effectiveness of Ethrel treatment depends on several factors, particularly ambient temperature and tree vigour. The response time of the tree to Ethrel application increases with higher temperatures and decreases at lower temperatures. For this reason, apply Ethrel only in the temperature range of 18–30°C. Remember, hot weather shortens the time needed for response.

- **Tree Vigour:** Tree vigour also affects the effectiveness of Ethrel treatment. Do not spray trees that have low vigour or are severely stressed by drought, disease or winter injury, which is indicated by gumming on the trunk and scaffold limbs. Only treat trees that are vigorous and in good health.

- **Rates:** Apply ethephon at a rate of 2.75 L/ha (applied in approx. 2,400 L of water per ha). Fruit should be enlarging rapidly, with the grass-green colour beginning to turn yellow or develop a tinge of red. This generally coincides with 7–14 days before anticipated harvest. This rate helps to loosen fruit to facilitate mechanical harvesting. Consult the product manufacturer for further information.

- **Concentrate Spraying:** Application of ethephon in concentrate sprays (i.e. 1,000 L of water per ha or less) achieves the same level of loosening as dilute applications. Uniform coverage is important.

- **Tank-mixing:** There is little or no data regarding tank-mixing ethephon. Do not tank mix with foliar nutrients or compounds such as fruit-cracking inhibitors, etc. While no problems have been reported by growers for tank-mixing ethephon with the fungicides and insecticides commonly used at this time, it is possible these materials may act as a buffer to the ethephon and thereby alter activity.

Gibberellic acid

To moderate early production, apply gibberellic acid (GA) at 15 ppm in the fourth year. This allows flowering in year five at a reasonable level rather than allowing heavy bloom and production. Overproduction can significantly reduce growth in future years.

For mature Montmorency sour cherry trees infected with cherry yellows virus, apply GA annually. This helps maintain and extend high fruiting capacity and reduces occurrence of blind nodes through the stimulation of lateral shoots and spurs.

Apply about three weeks after full bloom, from shuck fall to two weeks after shuck fall. Use concentrations of 10–20 ppm (15 ppm is most common). Use lower rates on more vigorous trees. For specific application instructions, which include temperature and humidity, consult the product label.

Sweet Cherry Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

Products are listed by fungicide and insecticide group. Use products from different groups to prevent pest resistance. For resistance management, refer to *Pest Resistance to Insecticides, Fungicides, Miticides*, page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-7. *Products Used on Sweet Cherries*, page 182.

Diseases and Insects	Products	Rate	Comments
Dormant (before bud break)			
Bacterial canker	• Copper Spray • Guardsman Copper Oxychloride	6–9 kg/1,000 L water 6–9 kg/1,000 L water	Apply in early spring before bud break. Later applications in the spring may cause injury. Use low rate on small trees, and high rate on large trees.
White bud			
Brown rot (blossom blight stage)	• Topas or Jade or Mission 418 EC • Nova 40 W • Indar 75 WSP • Funginex DC • Rovral • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG	500 mL/ha 500 mL/ha 300 mL/ha 340 g/ha 140 g/ha 2.5 L/ha 1.75 kg/ha 1.7 kg/ha 370 g/ha 370 g/ha 750 g/ha	These products are locally systemic and will penetrate petals to protect fruit from infection as bloom starts to occur. Consult labels for information on drying time required before rain. To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. See *Managing resistance to fungicides*, page 254 and Table 12-2, *Fungicide/Bactericide Groups Based on Sites of Action*, page 257.
Bloom			
DO NOT APPLY INSECTICIDES WHILE CHERRY TREES ARE IN BLOOM. SEE *BEE POISONING* ON PAGE 267.			
Brown rot (blossom blight stage)	• Topas or Jade or Mission 418 EC • Nova 40 W • Indar 75 WSP • Funginex DC • Rovral • Bravo 500 • Supra Captan 80 WDG or Maestro 80 DF • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG	500 mL/ha 500 mL/ha 300 mL/ha 340 g/ha 140 g/ha 2.5 L/ha 1.75 kg/ha 7 L/ha 4.5 kg/ha 4.5 kg/ha 1.7 kg/ha 370 g/ha 370 g/ha 750 g/ha	Blossom blight is favoured by wet, warm (above 16°C) weather, especially when large numbers of mummies are present in the trees. Apply sprays during the bloom period if weather remains favourable for blight or bloom is extended. **Funginex, Rovral, Topas, Jade, Mission, Indar, Nova, Elevate, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2, *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. Consult labels for information on drying time required before rain. **Nova, Funginex, Topas, Jade, Mission, Indar:** Do not rotate within this group. **Captan, Maestro, Bravo:** Do not use within 14 days of an application of Superior Oil. **Bravo:** Do not apply after shuck to avoid fruit injury. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus.

Diseases and Insects	Products	Rate	Comments
Petal fall			
Black cherry aphid	• Diazinon 50 WSP • Thionex 50 W • Movento 240 SC • Clutch 50 WDG	1 kg/1,000 L water 4.5 kg/ha 365 mL/ha 210 g/ha	**Diazinon, Thionex:** A temperature of at least 21°C, thorough coverage and a calm day are needed for effective aphid control. Usually 1–2 sprays are required. **Movento:** Most effective on young stages of aphids. Has slow activity; control may not be apparent for 2–3 weeks. Under high aphid pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. **Clutch:** Make first application before populations reach threshold.
Shuck fall			
Plum curculio	• Assail 70 WP • Clutch 50 WDG	240 g/ha 210 g/ha	Spray when most of the shucks are off and plum curculio activity is observed, usually when temperatures are above 16°C.
Brown rot	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Rovral • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG • Supra Captan 80 WDG or Maestro 80 DF	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 1.75 kg/ha 1.7 kg/ha 370 g/ha 370 g/ha 750 g/ha 4.5 kg/ha 4.5 kg/ha	**Rovral, Topas, Jade, Mission, Indar, Elevate, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2, *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. These products are locally systemic. Consult labels for information on drying time required before rain. **Captan and Maestro:** May cause leaf injury to Schmidt and Emperor Francis varieties in postbloom sprays. **Topas, Jade, Mission, Indar:** Do not rotate among these products. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus.
First cover (12 days after Shuck fall)			
Plum curculio	Use one of the insecticides listed under **Shuck fall.**		Monitor 7 days after shuck fall insecticide application for new plum curculio damage. Apply insecticide if new crescent-shaped cuts are found.
Brown rot	Use one of the fungicides listed under **Shuck fall.**		
Second cover (12 days after First cover)			
Cherry fruit fly	• GF-120 NF • Entrust 80 W • Admire 240 F • Diazinon 50 WSP	1.5 L/ha 109 g/ha 233 mL/ha 1 kg/1,000 L water	**GF-120:** Spray as soon as monitoring traps indicate flies are present or 2–3 weeks before ripening. GF-120 is a bait formulation that requires large droplet size (4–6 mm); specialized application equipment may be needed. GF-120 will lose effectiveness if exposed to rain or overhead irrigation. **Admire:** Monitor for cherry fruit fly and apply as a foliar spray within 6 days of first fly emergence. Thorough uniform coverage is necessary for optimal control. Allow at least 10 days between applications. **Diazinon:** On early varieties, check the preharvest interval. Spray when early varieties are beginning to colour. Provides 10 days protection against cherry fruit fly.
Plum curculio	• Assail 70 WP • Clutch 50 WDG	240 g/ha 210 g/ha	Monitor 7 days after previous insecticide for new plum curculio damage. Apply insecticide if new crescent-shaped cuts are found.

Diseases and Insects	Products	Rate	Comments
Brown rot	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Rovral • Supra Captan 80 WDG or Maestro 80 DF • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 1.75 kg/ha 4.5 kg/ha 4.5 kg/ha 1.7 kg/ha 370 g/ha 370 g/ha 750 g/ha	Alternate among groups and do not use products from the same group in consecutive sprays. **Topas, Jade, Mission:** Apply no more than two applications of any of these products in the three weeks prior to harvest. **Captan and Maestro:** May cause leaf injury to Schmidt and Emperor Francis varieties in postbloom sprays. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus.
Third cover			
Check preharvest interval before spraying early maturing cherries. See Table 7-7. *Products Used on Sweet Cherries,* page 182.			
Cherry fruit fly	• GF-120 NF • Entrust 80 W • Admire 240 F • Diazinon 50 WSP • Sevin XLR	1.5 L/ha 109 g/ha 233 mL/ha 1 kg/1,000 L water 6.25 L/ha	**GF-120:** Spray as soon as monitoring traps indicate flies are present or 2–3 weeks before ripening. GF-120 is a bait formulation that requires large droplet size (4–6 mm); specialized application equipment may be needed. GF-120 will lose effectiveness if exposed to rain or overhead irrigation. **Admire:** Monitor for cherry fruit fly and apply as a foliar spray within 6 days of first fly emergence. Thorough uniform coverage is necessary for optimal control. Allow at least 10 days between applications. **Sevin:** Provides 5–7 days protection.
Brown rot	Use one of the fungicides listed under **Second cover.**		
Prepick			
Check preharvest interval before spraying. See Table 7-7. *Products Used on Sweet Cherries,* page 182.			
Brown rot	• Indar 75 WSP • Topas or Jade or Mission 418 EC • Rovral • Supra Captan 80 WDG or Maestro 80 DF • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG	140 g/ha 500 mL/ha 500 mL/ha 300 mL/ha 1.75 kg/ha 4.5 kg/ha 4.5 kg/ha 1.7 kg/ha 370 g/ha 370 g/ha 750 g/ha	**Topas, Jade, Mission:** Apply no more than two applications in the three weeks prior to harvest. **Captan, Maestro:** May cause leaf injury to Schmidt and Emperor Francis varieties in postbloom sprays. **Pristine, Lance, Cantus:** Do not alternate Pristine with Lance or Cantus.
Postharvest orchard treatment			
Leaf spot	• Equal 65 WP • Supra Captan 80 WDG or Maestro 80 DF • Pristine WG • Flint 50 WG	2.25 kg/ha 4.5 kg/ha 4.5 kg/ha 750 g/ha 210 g/ha	Necessary only where leaf spot is a problem or where sweet cherries are beside sour cherries. **Captan, Maestro:** May cause leaf injury to the Schmidt and Emperor Francis varieties in postbloom sprays. **Pristine, Lance:** Do not rotate Pristine with Lance. **Flint:** Do not apply where spray drift may reach Concord grapes as it may cause crop injury.

Diseases and Insects	Products	Rate	Comments
Special sprays (when monitoring indicates the need)			
Obliquebanded leafroller (OBLR)	• Dipel 2X DF or Bioprotec CAF • Success 480 SC or Entrust 80 W • Delegate WG • Altacor • Rimon 10 EC	1.125 kg/ha 4 L/ha 182 mL/ha 109 g/ha 420 g/ha 285 g/ha 1.35–3.35 L/ha	Routine monitoring is necessary to determine if OBLR is causing damage in sweet cherries. **Altacor, Delegate, Rimon:** For OBLR summer generation, apply at 240–280 degree-days C (base 6.1°C) after biofix (first sustained moth catch). **Altacor:** Do not exceed 645 g/ha per year. For resistance management, if more than one spray is required for this generation, use a product from the same chemical group. For subsequent generations, rotate to another chemical group. **Dipel, Bioprotec:** See *Biopesticides for Insect Control*, page 247.
Postharvest fruit treatment			
Blue mould Grey mould Brown rot Rhizopus rot	• Scholar 230 SC • Bio-Save 10 LP	496 mL/378 L water 50 g/100 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions. **Bio-Save:** Labelled for blue mould and grey mould. Provides suppression rather than control of these storage rots. See *Pseudomonas syringae* (Bio-Save 10 LP), page 243 and Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control.
Fall spray			
Bacterial canker	• Copper Spray • Guardsman Copper Oxychloride	6–9 kg/1,000 L water 6–9 kg/1,000 L water	Apply when three-quarters of leaves have fallen.

Table 7-7. Products Used on Sweet Cherries

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used for control or suppression of insects and mites						
Admire 240 F	24094	imidacloprid	4	10 days	24 hours	5
Altacor	28981	chlorantraniliprole	28	10 days	12 hours	3 (max 645 g/ha)
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours/6 days[1]	4
Bioprotec CAF	26854	*Bacillus thuringiensis*	11	1 day		
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2
Delegate WG	28778	spinetoram	5	7 days	12 hours	3
Diazinon 50 WSP	29976	diazinon	1B	10 days	4 days	
Dipel 2X DF	26508	*Bacillus thuringiensis*	11	1 day		
Entrust 80 W	27825	spinosad	5	7 days		3
GF-120 NF	28336	spinosad	5	0 days		10
Movento 240 SC	28593	spirotetramat	23	7 days	12 hours	
Rimon 10 EC	28881	novaluron	15	14 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	2 days		

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period/exceptions are as follows: re-entry/hand thinning.

[2] Before shuck fall.

[3] Depends on rate, see label.

[4] No more than two applications in the 3 weeks prior to harvest.

[5] Re-entry period/exceptions are as follows: re-entry/hand harvest/hand thinning.

Table 7-7. Products Used on Sweet Cherries (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Success 480 SC	26835	spinosad	5	7 days		3
Thionex 50 W	14617	endosulfan	2A	18 days	7 days/20 days[1]	1
Products used for control or suppression of diseases						
Bio-Save 10 LP	29673	*Pseudomonas syringae* Strain ESC-10		postharvest		
Bravo 500	15723	chlorothalonil	M	40 days	48 hours	3[2]
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Copper Spray	19146	copper oxychloride	M		48 hours	
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Equal 65 WP	15608	dodine	M	7 days	48 hours	2[3]
Flint 50 WG	27529	trifloxystrobin	11	1 day	12 hours	2
Funginex DC	27686	triforine	3	do not use after bloom	48 hours	3
Guardsman Copper Oxychloride	13245	copper oxchloride	M		48 hours	
Indar 75 WSP	27294	fenbuconazole	3	1 day	12 hours	7
Jade	24030	propiconazole	3	3 days	72 hours	5[4]
Lance WDG	27495	boscalid	7	0 days	12 hours	5
Maestro 80 DF	26408	captan	M	2 days	48 hours	
Mission 418 EC	28016	propiconazole	3	3 days	72 hours	5[4]
Nova 40 W	22399	myclobutanil	3	1 day		
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days	When dry/ 24 hours/10 days[5]	5
Rovral	15213	iprodione	2	1 day	12 hours	
Scholar 230 SC	29528	fludioxonil	12	postharvest		
Supra Captan 80 WDG	24613	captan	M	2 days	48 hours	
Topas	30163	propiconazole	3	3 days	72 hours	5[4]

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period/exceptions are as follows: re-entry/hand thinning.

[2] Before shuck fall.

[3] Depends on rate, see label.

[4] No more than two applications in the 3 weeks prior to harvest.

[5] Re-entry period/exceptions are as follows: re-entry/hand harvest/hand thinning.

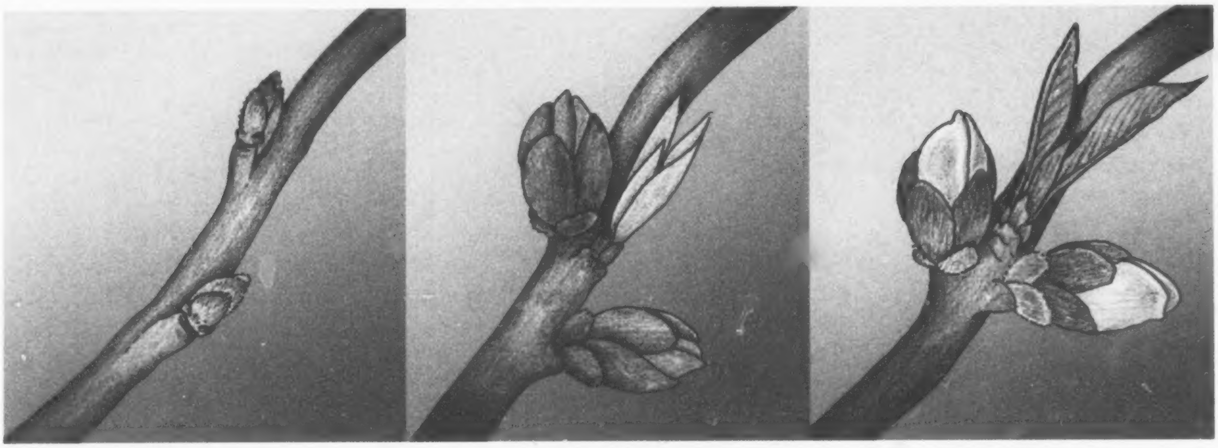
Growth Regulators for Sweet Cherries

To delay ripening and improve fruit quality of sweet cherries

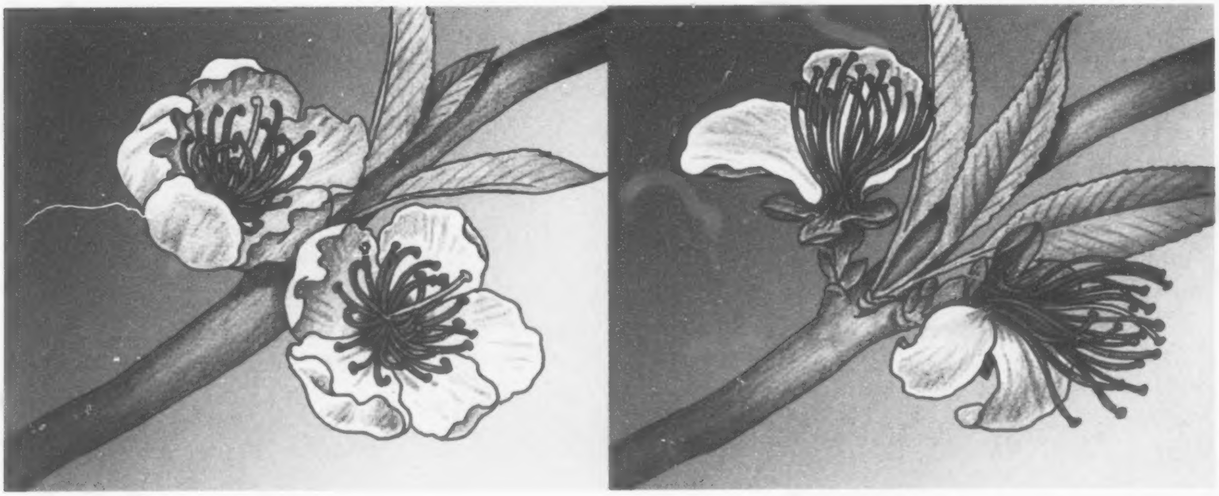
Research in British Columbia shows that gibberellic acid (GA) delays fruit ripening four to five days and thus extends the picking period, which may delay the susceptibility to rain cracks. The treatment also increases fruit size, firmness and resistance to postharvest disorders.

- Dissolve 20 Falgro® tablets in 1,000 L of water to produce a 20 ppm solution and apply as a foliar spray to runoff.
- Apply 21 days before normal harvest when the fruit is at the straw coloured stage.
- Harvest when fruits are at the desired shade of red but not within 21 days after spraying.

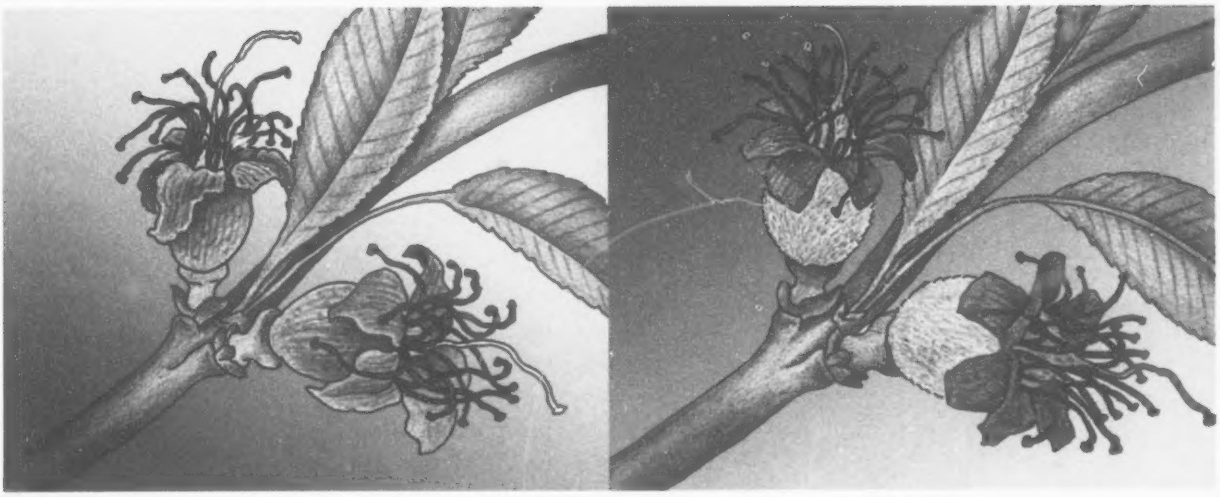
Figure 7-3. Peach Growth Stages



Dormant Quarter-inch Green Pink



Bloom Petal Fall



Shuck Shuck Split

Peach Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

Products are listed by fungicide and insecticide group. Use products from different groups to prevent pest resistance. For resistance management, refer to *Pest Resistance to Insecticides, Fungicides, Miticides*, page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-8. *Products Used on Peaches*, page 192.

Diseases and Insects	Products	Rate	Comments
Dormant (in March or early April before buds swell)			
Leaf curl	• Ferbam 76 WDG • Bravo 500 or Echo 720 • Copper Spray • Guardsman Copper Oxychloride	3.5 kg/1,000 L water 7 L/ha 3.5–6.3 L/ha 2 kg/1,000 L water 2 kg/1,000 L water	A delay in application may result in poor control of leaf curl. **Ferbam:** If mixing with oil, follow mixing directions on the Superior 70 Oil label carefully or poor leaf curl control will result. **Bravo, Echo:** Do not apply within 10 days of an oil application because it will burn flower and leaf tissue.
San Jose scale	• Superior 70 Oil • Purespray Green Spray Oil 13E	20 L/1,000 L water 20 L/1,000 L water	Apply oil routinely every third year. If scale is a serious or continuing problem, apply oil for at least two consecutive years.
Prebloom (half-inch green to first pink)			
European red mite	• Superior 70 Oil • Purespray Green Spray Oil 13E	20 L/1,000 L water 20 L/1,000 L water	This is the preferred time to use oil for red mite control if overwintering populations are high. Red mite populations are more likely to be high if pyrethroid sprays were used the previous year for oriental fruit moth and tarnished plant bug control.
Oriental fruit moth (OFM)	• Isomate-M Rosso • Isomate-M 100	500 dispensers/ha 250 dispensers/ha	Pheromone mating disruption products are not insecticides and will not control other pests that may be present. Initial OFM population must be low. Apply to square or rectangular orchard blocks at least 4 ha in size. This technology may be used in peach orchards that are less than 4 ha but are adjacent to orchards of sufficient size, if both are using this technology. Must be applied before moth flight begins. For more information on mating disruption refer to OMAFRA Factsheets *Mating Disruption for Management of Insect Pests*, Order No. 03-079 and *Mating Disruption for Management of Oriental Fruit Moth in Stone and Pome Fruit*, Order No. 04-029. **Isomate-M 100:** Make a second application 75–80 days after initial application. **Isomate-M Rosso:** Provides mating disruption for up to 120 days. If desired, use both an insecticide and mating disruption for managing first generation OFM (see **Shuck split**).
Pink			
Blossom blight stage of brown rot	• Topas or Jade or Mission 418 EC • Nova 40 W • Indar 75 WSP • Funginex DC • Rovral • Vangard 75 WG • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG	500 mL/ha 500 mL/ha 300 mL/ha 340 g/ha 140 g/ha 2.5 L/ha 1.5 kg/ha 370 g/ha 1.7 kg/ha 370 g/ha 370 g/ha 750 g/ha	These products are locally systemic and will penetrate petals to protect fruit from infection as blossoms starts to open. Consult labels for information on drying time required before rain. To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257.

Diseases and Insects	Products	Rate	Comments
Bloom			
DO NOT APPLY INSECTICIDES WHILE PEACH TREES ARE IN BLOOM. SEE *BEE POISONING* ON PAGE 267.			
Blossom blight stage of brown rot	• Topas	500 mL/ha	Spray when first blossoms are opening. Repeat every 4–5 days if weather is wet. **Rovral, Topas, Jade, Mission, Indar, Funginex, Vangard, Elevate, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/ Bactericide Groups Based on Sites of Action*, page 257. These products are locally systemic. Consult labels for information on drying time required before rain. **Nova, Funginex, Topas, Jade, Mission, Indar:** Do not rotate among these products. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus. **Bravo, Echo, Captan, Maestro:** Do not apply within 10 days of an oil application, because this causes burning of flower and leaf tissue. **Sulphur:** May encourage mite build-up.
	or Jade	500 mL/ha	
	or Mission 418 EC	300 mL/ha	
	• Nova 40 W	340 g/ha	
	• Indar 75 WSP	140 g/ha	
	• Funginex DC	2.5 L/ha	
	• Rovral	1.5 kg/ha	
	• Vangard 75 WG	370 g/ha	
	• Elevate 50 WDG	1.7 kg/ha	
	• Lance WDG	370 g/ha	
	or Cantus WDG	370 g/ha	
	• Pristine WG	750 g/ha	
	• Bravo 500	7 L/ha	
	or Echo 720	3.5–6.3 L/ha	
	• Supra Captan 80 WDG	4.5 kg/ha	
	or Maestro 80 DF	4.5 kg/ha	
	• Microscopic Sulphur	6.5 kg/1,000 L water	
Petal fall to shuck			
Aphids	• Movento 240 SC	365 mL/ha	**Movento:** Most effective on young stages of aphids. Has slow activity; control may not be apparent for 2–3 weeks. Under high aphid pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. **Clutch:** Use the higher rate and shortest interval when insect pressure is high. If monitoring indicates the need, a second application may be made 10–14 days after the first application. **Beleaf:** Use higher rates for greater pest populations and/or dense foliage. **Purespray Green Spray Oil 13E:** Provides suppression of aphids. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides, and Fungicides,* page 13, for definitions of suppression and control. Summer oils can cause crop injury, depending on rate, cultivar, weather conditions, and recent pesticide applications. Do not apply less than 1,000 L water/ha (1% solution). Not all varieties have been tested for tolerance, so spray a small area of each variety to confirm tolerance prior to spraying the whole field. Do not apply within 14 days of Captan, Maestro, Bravo, Echo, Pounce, Perm-Up, or products containing sulphur. Do not apply within 48 hours of freezing temperatures. Do not apply when temperatures are very high (above 25°C) or to crops under moisture stress. Do not apply just prior to rain. Read the label carefully for other precautions. See notes on *Mineral oil (Purespray Green Spray Oil 13E),* page 252.
	• Clutch 50 WDG	140–210 g/ha	
	• Beleaf 50 SG	120–160 g/ha	
	• Purespray Green Spray Oil 13E	10 L/1,000 L water	

Diseases and Insects	Products	Rate	Comments
Green peach aphid	• Admire 240 F • Clutch 50 WDG • Purespray Green Spray Oil 13E	230 mL/ha 140–210 g/ha 10 L/1,000 L water	Thresholds for application are 30% of terminals infested or 20 colonies per tree for peaches and 10% of terminals infested or 5–10 colonies per tree for nectarines. **Clutch:** Use the higher rate and shortest interval when insect pressure is high. If monitoring indicates the need, a second application may be made 10–14 days after the first application. **Purespray Green Spray Oil 13E:** Provides suppression of aphids. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides, and Fungicides*, page 13, for definitions of suppression and control. Summer oils can cause crop injury, depending on rate, cultivar, weather conditions, and recent pesticide applications. Do not apply less than 1,000 L water/ha (1% solution). Not all varieties have been tested for tolerance, so spray a small area of each variety to confirm tolerance prior to spraying the whole field. Do not apply within 14 days of Captan, Maestro, Bravo, Echo, Pounce, Perm-Up, or products containing sulphur. Do not apply within 48 hours of freezing temperatures. Do not apply when temperatures are very high (above 25°C) or to crops under moisture stress. Do not apply just prior to rain. Read the label carefully for other precautions. See notes on *Mineral oil (Purespray Green Spray Oil 13E)*, page 252.
Shuck split to shuck fall			
Oriental fruit moth (OFM) (first generation)	• Assail 70 WP • Intrepid 240 F • Rimon 10 EC • Lorsban 50 W	120–240 g/ha 1.5 L/ha 1.35–3.35 L/ha 3.5 kg/ha	Products are recommended at different timings because they work best on specific life stages of the pest. Apply within the appropriate degree-days specified for best results. Monitor populations and re-apply 10–14 days later if required. Where mating disruption products for OFM have been placed in the orchard, a pesticide application is generally not required at this time. **Assail, Intrepid, Rimon:** Apply at first egg hatch 80–120 degree-days C (base 7.2°C) after first sustained moth catch in pheromone traps. **Intrepid, Assail:** Apply in 1,000 L water/ha. **Assail:** For optimum activity, use the 240 g/ha rate. Do not apply more than once every 12 days. Will also suppress/control plum curculio. **Intrepid:** Apply only once for first generation. **Lorsban, Intrepid:** Use for the control of first generation only. **Lorsban:** Apply at 200 degree-days C (base 7.2°C) after first sustained moth catch in pheromone traps. Do not use pyrethroids for control of first generation OFM.
Plum curculio	• Assail 70 WP • Clutch 50 WDG	240 g/ha 210 g/ha	Plum curculio is a sporadic pest of peaches and nectarines. Scout edges of orchards near woodlots and wild hosts in spring. Check small fruit for crescent-shaped egg laying scars. A border spray of 4–6 rows may provide sufficient control. Check developing fruit for new damage 7–10 days later. **Assail:** Under high insect pressure, may provide suppression rather than control of plum curculio.
Peachtree borer	• Isomate-P	250–625 dispensers/ha	**Isomate-P:** Reduces mating of peachtree borer adults. Not effective on lesser peachtree borer. Initial population must be low for good results. Use in square or rectangular orchard blocks at least 4 ha in size; larger blocks are preferred. Apply pheromone dispensers before peachtree borer flight begins in the spring. The dispenser is designed to last an entire season, so early placement (shuck-split or earlier) will not reduce effectiveness. Attach the dispensers onto branches about the mid-point of the tree. Apply at least 250 dispensers per ha for low pressure sites and up to 625 dispensers per ha for high pressure sites. In addition to mating disruption, an insecticide for peachtree borer may be needed in high pressure sites. Populations are generally reduced over time where mating disruption is used for several seasons. For more information see *Using Mating Disruption in Fruit Crops*, page 248.

Diseases and Insects	Products	Rate	Comments
Brown rot	• Topas	500 mL/ha	This is a critical period for infection as the fungus can grow from the dying shuck into the susceptible fruit. This results in latent infections that are not expressed until the fruit starts to mature. Spray again in 7 days if wet weather persists. **Rovral, Topas, Jade, Mission, Indar, Vangard, Elevate, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2, *Fungicide/Bactericide Groups Based on Sites of Action*, page 257. These products are locally systemic. Consult labels for information on drying time required before rain. **Topas, Jade, Mission, Indar:** Do not rotate among these products. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus. **Pristine:** Do not apply where spray drift may reach Concord grapes as it may cause crop injury. **Sulphur:** May induce mite problems.
	or Jade	500 mL/ha	
	or Mission 418 EC	300 mL/ha	
	• Indar 75 WSP	140 g/ha	
	• Vangard 75 WG	740 g/ha	
	• Elevate 50 WDG	1.7 kg/ha	
	• Lance WDG	370 g/ha	
	or Cantus WDG	370 g/ha	
	• Pristine WG	750 g/ha	
	• Rovral	1.5 kg/ha	
	• Supra Captan 80 WDG	4.5 kg/ha	
	or Maestro 80 DF	4.5 kg/ha	
	• Microscopic Sulphur	6.5 kg/1,000 L water	
Scab	• Kumulus DF	22.5 kg/ha	Peaches are susceptible to peach scab fruit infections from shuck fall to about 4–6 weeks before harvest; on nectarine, the susceptible period begins earlier (at shuck split) due to the lack of protective hairy fruit covering. This period marks the greatest scab risk, given the presence of large spore numbers and the increased susceptibility of the developing fruit. Closely spaced applications with effective fungicides are recommended, particularly for the shuck fall application and during rainy weather. See Table 7-11. *Activity of Fungicides on Tender Fruit Diseases*, page 214, for products that control scab.
	or Microthiol Disperss	22.5 kg/ha	
	or Microscopic Sulphur	6.5 kg/1,000 L water	
	• Supra Captan 80 WDG	3.75–4.5 kg/ha	
	or Maestro 80 DF	3.75–4.5 kg/ha	
European red mite	• Apollo SC	300 mL/ha	If oil was applied in the spring, a miticide is likely not necessary at this time. **Apollo:** Most effective on eggs and newly hatched nymphs. Apply when leaf tissue is present, mites are mostly in the first summer generation egg stage and before there are three active mites per leaf. Use sufficient water volumes to obtain good coverage, but not less than 475 L/ha. Apply up to 14 days after petal fall.
Lesser peachtree borer	• Thionex 50 W	1.5 kg/1,000 L water	Peachtree borers are sporadic pests. Spray in areas with high borer populations. Use pheromone traps to monitor adult activity and begin sprays one week after first flight. Make three applications at 5–10 day intervals. Direct these sprays with a handgun to cover trunk and scaffold limbs thoroughly; do not spray fruit. Do not apply second Thionex spray to varieties in the Harrow Diamond and Garnet Beauty season; on these varieties use Sevin XLR. Do not use third Thionex spray on varieties in the Sunhaven, Redhaven, Veecling and Vivid season; on these varieties use Sevin XLR. Sevin XLR is not registered for peachtree borer.
Peachtree borer	• Sevin XLR	6.25 L/ha	
Special sprays (when monitoring indicates the need during early green fruit stage to pit hardening)			
Tarnished plant bug	• Ripcord 400 EC	175 mL/ha	General timing is mid-June if 2% or more fruit damage is observed. Where plant bug pressure is high and significant new damage is detected, repeat spray in 5–7 days. Plant bug pressure is lower in orchards with managed sod. Other cultural techniques can reduce damage from this pest. **Ripcord:** Also controls oak bug. **Up-Cyde:** Use in 550 L water/ha.
	or Up-Cyde 2.5 EC	280 mL/ha	
	• Matador 120 EC	104 mL/ha	
	or Silencer 120 EC	104 mL/ha	
	• Ambush 500 EC	400 mL/ha	

Diseases and Insects	Products	Rate	Comments
Second generation oriental fruit moth (OFM) spray			
Oriental fruit moth (OFM) (Second generation)	• Assail 70 WP • Rimon 10 EC • Altacor • Delegate WG • Ripcord 400 EC or Up-Cyde 2.5 EC • Matador 120 EC or Silencer 120 EC • Ambush 500 EC or Pounce 384 EC or Perm-Up • Decis 5 EC	120–240 g/ha 1.35–3.35 L/ha 285 g/ha 420 g/ha 175 mL/ha 280 mL/ha 104 mL/ha 104 mL/ha 200–400 mL/ha 275 mL/ha 275 mL/ha 200 mL/ha	Spray all varieties. This generation may require two insecticide sprays. Products are recommended at different timings because they work best on specific life stages of the pest. Apply within the appropriate degree-days specified for best results. Monitor populations and re-apply 10–14 days later if required. Check the harvest dates of early varieties and do not spray within the preharvest interval. If mating disruption for OFM is being used a pesticide application is not required for second generation OFM. **Rimon:** Apply before peak egg-laying, 555–583 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). **Assail:** Apply before first egg hatch, 583–611 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). For optimum activity, use the 240 g/ha rate. Apply in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Will also control plum curculio. **Altacor, Delegate, Ripcord, Up-Cyde, Matador, Silencer, Ambush, Pounce, Perm-Up, Decis:** Apply at first egg hatch, 640–670 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). **Altacor:** Do not exceed 645 g/ha per year. **Up-Cyde:** Use in 550 L water/ha. **Decis:** Maximum one application per year. For resistance management, if more than one spray is required for this generation, use a product from the same chemical group. For subsequent generations rotate to another chemical group.
Brown rot (early varieties only – Harrow Diamond through Sunhaven)	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Vangard 75 WG • Elevate 50 WDG • Lance WDG or Cantus WDG • Pristine WG • Rovral • Supra Captan 80 WDG or Maestro 80 DF • Microscopic Sulphur	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 740 g/ha 1.7 kg/ha 370 g/ha 370 g/ha 750 g/ha 1.5 kg/ha 4.5 kg/ha 4.5 kg/ha 6.5 kg/1,000 L water	Rotate among fungicide groups; do not use products from the same group in consecutive sprays. **Topas, Jade, Mission:** Maximum two applications of any of these products in the three weeks prior to harvest. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus. **Sulphur:** May induce mite problems.
Scab	• Kumulus DF or Microthiol Disperss or Microscopic Sulphur • Supra Captan 80 WDG or Maestro 80 DF	22.5 kg/ha 22.5 kg/ha 6.5 kg/1,000 L water 3.75–4.5 kg/ha 3.75–4.5 kg/ha	Peaches are susceptible to peach scab fruit infections from shuck fall to about 4–6 weeks before harvest; on nectarine, the susceptible period begins earlier (at shuck split) due to the lack of protective hairy fruit covering. This period marks the greatest scab risk, given the presence of large spore numbers and the increased susceptibility of the developing fruit. Closely spaced applications with effective fungicides are recommended, particularly for the shuck fall application and during rainy weather. See Table 7-11. *Activity of Fungicides on Tender Fruit Diseases,* page 214, for products that control scab.

Diseases and Insects	Products	Rate	Comments
Special sprays (when monitoring indicates the need)			
European red mite Two-spotted spider mite	• Nexter • Envidor 240 SC • Carzol SP Instapak	300 g/ha 750 mL/ha 1.1 kg/ha	Check product labels for preharvest intervals in Table 7-8. *Products Used on Peaches,* page 192. Apply this spray around the second OFM spray (early July) if needed. On cultivars Harbrite and later, examine for mites again 3 weeks before harvest. Spray if 5–10 active pest mites per leaf are present in July and few beneficial mites are present. Monitor carefully because populations of pest mites can build rapidly. Miticides are best used alone. Use a minimum water volume of 1,000 L/ha for effective control. **Nexter:** Most effective when applied to mite nymphs. Use 600 g/ha for two-spotted spider mites. **Envidor:** Works slowly, especially in cool weather. Control may not be apparent for 2–3 weeks. Apply before mite populations build up. **Carzol:** The majority of the mite population should be in the young nymphal stage. Do not apply after petal fall.
Third generation oriental fruit moth (OFM) spray (late varieties)			
Check preharvest interval before spraying early maturing peaches. See Table 7-8. *Products Used on Peaches,* page 192.			
Oriental fruit moth (OFM)	• Assail 70 WP • Rimon 10 EC • Altacor • Delegate WG • Ripcord 400 EC or Up-Cyde 2.5 EC • Pounce 384 EC or Perm-Up or Ambush 500 EC • Decis 5 EC • Silencer 120 EC	120–240 g/ha 1.35–3.35 L/ha 285 g/ha 420 g/ha 175 mL/ha 280 mL/ha 275 mL/ha 275 mL/ha 200–400 mL/ha 200 mL/ha 104 mL/ha	This spray is usually required for all varieties from Vivid season and later. Check the preharvest intervals. Monitor populations and re-apply 10–14 days later if required. Products are recommended at different timings because they work best on specific life stages of the pest. Apply within the appropriate degree-days specified for best results. If mating disruption for OFM is being used, a pesticide application is not required for third generation OFM. **Assail:** Apply before first egg hatch at 1,111-1,167 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). For optimum activity, use the 240 g/ha rate. Apply in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. **Rimon:** Apply before peak egg laying, 1,083-1,169 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). **Altacor, Delegate, Ripcord, Up-Cyde, Pounce, Perm-Up, Ambush, Decis, Silencer:** Apply at first egg hatch at 1,167-1,222 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). Monitor populations and re-apply 10–14 days later if required. Do not spray within the preharvest interval of 10 days. **Altacor:** Do not exceed 645 g/ha per year. **Up-Cyde:** Use in 550 L water/ha. **Decis:** Maximum one application per year. For resistance management, if more than one spray is required for this generation, use a product from the same chemical group. For subsequent generations, rotate to another chemical group. See Table 12-3. *Insecticide and Miticide Groups Based on Sites of Action*, page 258.

Diseases and Insects	Products	Rate	Comments
Brown rot	• Topas	500 mL/ha	Alternate among fungicide groups; do not use products from the same group in consecutive sprays. **Topas, Jade, Mission:** Maximum two applications in the three weeks prior to harvest. **Pristine, Lance, Cantus:** Do not alternate Pristine with Lance or Cantus. **Sulphur:** May induce mite problems.
	or Jade	500 mL/ha	
	or Mission 418 EC	300 mL/ha	
	• Indar 75 WSP	140 g/ha	
	• Vangard 75 WG	740 g/ha	
	• Elevate 50 WDG	1.7 kg/ha	
	• Lance WDG	370 g/ha	
	or Cantus WDG	370 g/ha	
	• Pristine WG	750 g/ha	
	• Rovral	1.5 kg/ha	
	• Supra Captan 80 WDG	4.5 kg/ha	
	or Maestro 80 DF	4.5 kg/ha	
	• Microscopic Sulphur	6.5 kg/1,000 L water	
Prepick spray			
Check preharvest interval before spraying early maturing peaches. See Table 7-8. *Products Used on Peaches,* page 192.			
Oriental fruit moth (OFM)	• Decis 5 EC	200 mL/ha	Spray each variety when first colour shows, 7–14 days before first harvest. If mating disruption is being used for OFM, a prepick spray is not necessary unless local populations have historically been high or in cases where late season peaches are the only remaining fruit in an area. **Decis:** Maximum one application per year. **Up-Cyde:** Use in 550 L water/ha. **Assail:** For optimum activity, use the 240 g/ha rate. Apply in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. For resistance management, if more than one spray is required for this generation, use a product from the same chemical group. For subsequent generations rotate to another chemical group. See Table 12-3. *Insecticide and Miticide Groups Based on Sites of Action,* page 258.
	• Ripcord 400 EC	175 mL/ha	
	or Up-Cyde 2.5 EC	280 mL/ha	
	• Pounce 384 EC	275 mL/ha	
	or Perm-Up	275 mL/ha	
	or Ambush 500 EC	200–400 mL/ha	
	• Silencer 120 EC	104 mL/ha	
	• Altacor	285 g/ha	
	• Delegate WG	420 g/ha	
	• Assail 70 WP	120–240 g/ha	
	• Rimon 10 EC	1.35–3.35 L/ha	
Brown rot	• Topas	500 mL/ha	Apply with OFM sprays 7–10 days before harvest. Alternate among fungicide groups; do not use products from the same group in consecutive sprays. **Pristine, Lance, Cantus:** Do not rotate Pristine with Lance or Cantus. **Topas, Jade, Mission, Indar:** Do not rotate among these products. **Topas, Jade, Mission:** Maximum two applications of any of these products in the three weeks prior to harvest. **Sulphur:** Use may induce mite problems.
	or Jade	500 mL/ha	
	or Mission 418 EC	300 mL/ha	
	• Indar 75 WSP	140 g/ha	
	• Vangard 75 WG	740 g/ha	
	• Elevate 50 WDG	1.7 kg/ha	
	• Lance WDG	370 g/ha	
	or Cantus WDG	370 g/ha	
	• Pristine WG	750 g/ha	
	• Rovral	1.5 kg/ha	
	• Supra Captan 80 WDG	4.5 kg/ha	
	or Maestro 80 DF	4.5 kg/ha	
	• Microscopic Sulphur	6.5 kg/1,000 L water	
Postharvest fruit treatment			
Blue mould Grey mould Brown rot Rhizopus rot	• Scholar 230 SC	496 mL/378 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions.

Diseases and Insects	Products	Rate	Comments
Fall spray (preferred time to spray for leaf curl)			
Leaf curl	• Bravo 500 or Echo 720	7 L/ha 3.5–4.9 L/ha	Apply any time after leaves are off in fall or winter when temperature in shade is above freezing and conditions favour rapid drying.
	• Copper Spray • Guardsman Copper Oxychloride	2 kg/1,000 L water 2 kg/1,000 L water	

Table 7-8. Products Used on Peaches

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used for control or suppression of insects and mites						
Admire 240 F	24094	imidacloprid	4	7 days	24 hours	2
Altacor	28981	chlorantraniliprole	28	10 days	12 hours	3 (max 645 g/ha)
Ambush 500 EC	14882	permethrin	3	7 days		
Apollo SC	21035	clofentezine	10	21 days	12 hours	1
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours/6 days[1]	4
Beleaf 50 SG	29796	flonicamid	9	14 days	12 hours/48 hours[1]	3
Carzol SP Instapak	29991	formetanate hydrochloride	1A	not after petal fall	12 days/14 days/ 19 days [2]	1
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2
Decis 5 EC	22478	deltamethrin	3	1 day		1
Delegate WG	28778	spinetoram	5	14 days	12 hours	3
Envidor 240 SC	28051	spirodiclofen	23	7 days	12 hours	1
Intrepid 240 F	27786	methoxyfenozide	18	14 days	12 hours	
Lorsban 50 W	20944	chlorpyrifos	1B	21 days	4 days	2
Matador 120 EC	24984	lambda-cyhalothrin	3	7 days	24 hours	3
Movento 240 SC	28593	spirotetramat	23	7 days	12 hours	
Nexter	25135	pyridaben	21	14 days	24 hours	1
Perm-Up	28877	permethrin	3	7 days	12 hours	
Pounce 384 EC	16688	permethrin	3	7 days		
Purespray Green Spray Oil 13E	27666	mineral oil			12 hours	
Ripcord 400 EC	15738	cypermethrin	3	7 days		2
Rimon 10 EC	28881	novaluron	15	14 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	1 day		
Silencer 120 EC	29052	lambda-cyhalothrin	3	7 days	24 hours	3
Superior 70 Oil	9542 14981	mineral oil		apply prebloom	12 hours	
Thionex 50 W	14617	endosulfan	2A	18 days	7 days/20 days[1]	3
Up-Cyde 2.5 EC	28795	cypermethrin	3	7 days	12 hours	2

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period/exceptions are as follows: re-entry/hand thinning.

[2] Re-entry period/exceptions are as follows: scouting, weeding, irrigating/ hand harvest, hand pruning training, propping/ hand thinning.

[3] No more than two applications in the 3 weeks prior to harvest.

[4] Re-entry period/exceptions are as follows: re-entry/hand harvest/hand thinning.

Table 7-8. Products Used on Peaches (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used for control or suppression of diseases						
Bravo 500	15723	chlorothalonil	M	60 days	48 hours	4
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Copper Spray	19146	copper oxychloride	M		48 hours	
Echo 720	29355	chlorothalonil	M	40 days	48 hours	3
Elevate 50 WDG	25900	fenhexamid	17	1 day	4 hours	4
Ferbam 76 WDG	20136	ferbam	M	21 days		
Funginex DC	27686	triforine	3	do not apply after bloom	48 hours	3
Guardsman Copper Oxychloride	13245	copper oxychloride	M		48 hours	
Indar 75 WSP	27294	fenbuconazole	3	1 day	12 hours	7
Jade	24030	propiconazole	3	3 days	72 hours	5[3]
Kumulus DF	18836	sulphur	M	1 day	24 hours	
Lance WDG	27495	boscalid	7	0 days	12 hours	5
Maestro 80 DF	26408	captan	M	2 days	48 hours	
Microscopic Sulphur	14653	sulphur	M	1 day	24 hours	
Microthiol Disperss	29487	sulphur	M	1 day	24 hours	
Mission 418 EC	28016	propiconazole	3	3 days	72 hours	5[3]
Nova 40 W	22399	myclobutanil	3	1 day		6
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days	When dried/ 24 hours/10 days[4]	5
Rovral	15213	iprodione	2	1 day	12 hours	
Scholar 230 SC	29528	fludioxonil	12	postharvest		
Supra Captan 80 WDG	24613	captan	M	2 days	48 hours	
Topas	30163	propiconazole	3	3 days	72 hours	5[3]
Vangard 75 WG	25509	cyprodinil	9	2 days	72 hours	4

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period/exceptions are as follows: re-entry/hand thinning.

[2] Re-entry period/exceptions are as follows: scouting, weeding, irrigating/ hand harvest, hand pruning training, propping/ hand thinning.

[3] No more than two applications in the 3 weeks prior to harvest.

[4] Re-entry period/exceptions are as follows: re-entry/hand harvest/hand thinning.

Thinning Peaches

Peach thinning is an essential orchard management practice. Thinning is necessary to obtain good-sized, quality fruit and to reduce limb breakage, loss of tree vigour, shortened orchard life and pest management problems.

When thinning, consider fruit load as well as fruit spacing. Optimum fruit load depends on cultivar, tree vigour, tree age and health, and orchard management practices such as tree spacing, irrigation and pruning. Peach growers tend to space the fruit 15–20 cm apart. However, distance between fruit is less critical as long as clusters are broken up and fruit is separated. Tree crop load (kg per tree or number of fruit per tree) is a more important consideration. As an example, a yield of 18–27 tonnes/ha (8–12 tons/acre) in an orchard with a tree density of 490 trees per ha (200 trees per acre) requires about 200–300 fruit per tree, if you assume an average fruit size of 4–7 fruit per kg (2–3 fruit per lb). With current emphasis on increased fruit size for better marketability and trends towards higher tree densities, fruit loads of 175–200 fruit per tree may be more ideal, at least for cultivars that normally produce large fruit.

Factors to consider when thinning peaches

Timing – Start hand thinning near the end of June drop (about mid-June) when it can be determined which fruits will abort and fall on their own. Thinning at early fruit development or even blossom time is more beneficial than late thinning. However, it is difficult to get a true assessment of crop load before June drop occurs. Always thin early-ripening cultivars in order to obtain good fruit size. In some years, a follow-up hand thinning may be necessary.

Pruning – Pruning is an essential part of the fruit-thinning procedure. Pruning selectively removes fruit-bearing surface, as well as some of the excess crop. Normal fruit thinning must follow to avoid over-cropping.

Cultivars – Cultivar selection over the years has tended towards larger fruit. Earlier ripening cultivars have a high percentage of fruit with split pits. Some growers thin early cultivars twice; thinning lightly to remove some crop load, then a second time to selectively remove split-pit fruit. Harrow Diamond is the earliest-ripening commercial cultivar that has few split-pit fruits under normal conditions. This cultivar must be well thinned to obtain suitable size. There is little likelihood of over-thinning early cultivars when the set is heavy. Heavy-setting, hard-to-size cultivars such as Redhaven require heavier thinning than easier-to-size types like Vivid and Loring. As a rule of thumb, late maturing cultivars with a good, uniform set are thinned to 10–13 cm between fruit in order to produce good-sized fruit. Thin each cultivar according to its individual requirements.

Irrigation – Irrigation is recommended to enhance fruit size, especially in long periods of dry conditions. There are two key periods to irrigate peaches; during cell division (from bloom to 30 days after bloom) and during cell expansion (approximately 2–4 weeks before harvest). Start irrigation early in the season and continue a regular schedule based on the amount of rainfall, rate of evapo-transpiration and soil water holding capacity. Permanent orchard sod is very competitive and increases moisture requirements. Adjust the irrigation schedule based on additional factors such as crop load, winter injury, insect, disease or other stress factors. New technology is being developed for commercial growers to closely monitor soil moisture. Orchards without irrigation may, in some years, need a second thinning during July to attain marketable fruit size.

Thinning methods – Thinning is most commonly accomplished by hand. Large quantities of fruit can be removed quickly with physical aids such as a child's plastic bat, a rubber hose mounted on a bamboo pole or broom handle, or a plastic rake manufactured for this purpose. Follow this initial thinning with "touch-up" thinning a few days later to assure that fruit numbers per tree produce good-sized fruit for the cultivar and orchard condition. Ensure clusters of fruit are broken up and fruit separated. If the set is spotty on the tree, more fruit may be left on the heavy-set branches.

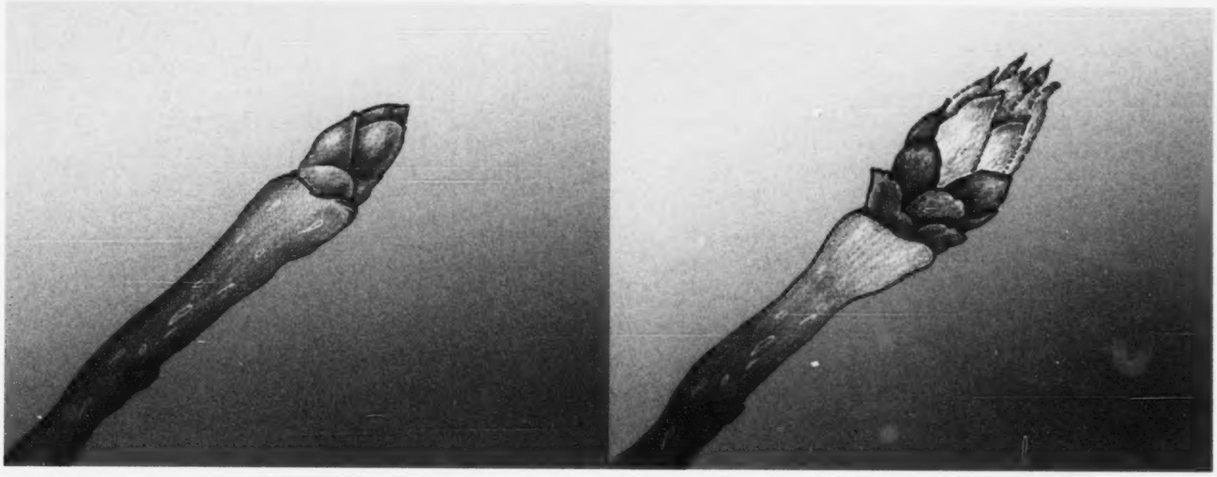
Other methods that have been investigated are:

Mechanical blossom thinning – Mechanical trunk shakers used in the past have resulted in over-thinning and had long-term negative effects on the root system of the tree. A relatively new device using nylon cords fixed to a rotating shaft mounted on a front-end loader is showing promise for blossom removal. Tractor speed, the rpm of the nylon cords, the number of cords used, tree shape and the timing during blossom can affect the number of blossoms removed. Follow-up hand thinning is necessary to ensure good fruit size. Mechanical blossom thinning helps to reduce labour costs, and results in larger average fruit size per tree and earlier ripening. This new technology may work best in high density, vertically trained spindle orchards.

Chemical thinning – No chemicals are registered for thinning peaches in Ontario.

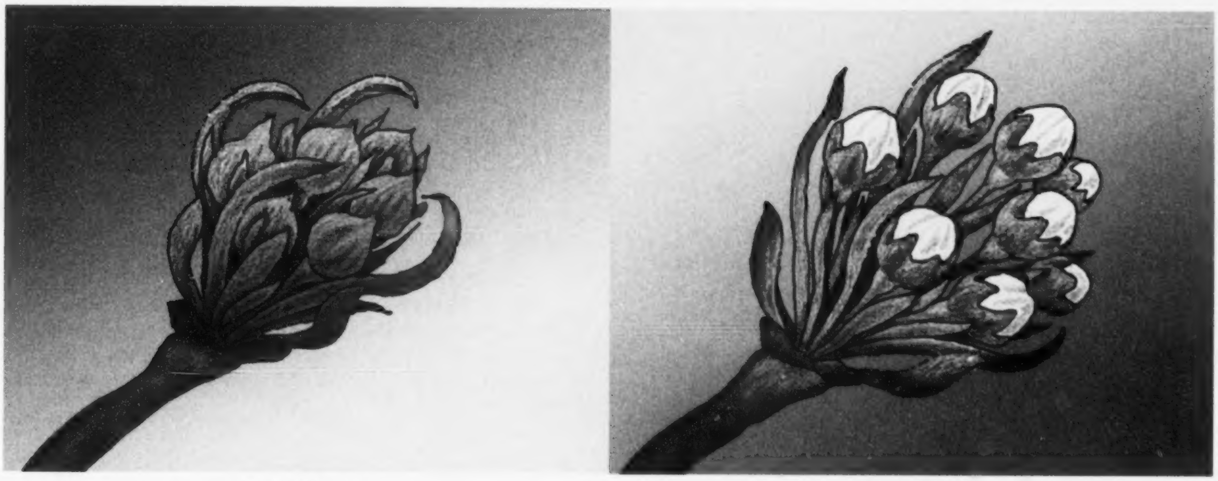
All of the above methods must be supplemented by touch-up hand thinning.

Figure 7-4. Pear Growth Stages



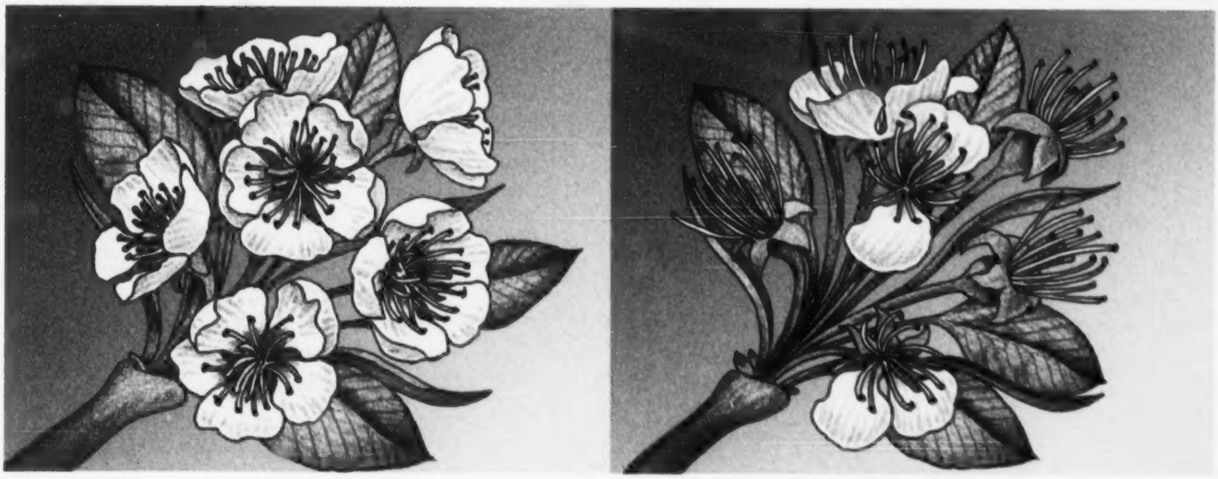
Dormant

Green Tip



Tight Cluster

White Bud



Bloom

Petal Fall / Calyx

Pear Calendar

Read the product label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

Products are listed by fungicide and insecticide group. Use products from different groups to prevent pest resistance. For resistance management, refer to *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-9. *Products Used on Pears,* page 204.

Diseases and Insects	Products	Rate	Comments
Dormant			
Scale insects Pear psylla	• Superior 70 Oil • Purespray Green Spray Oil 13E	20 L/1,000 L water 20 L/1,000 L water	Use 2,000–3,000 L of water/ ha. Good coverage is essential. Do not apply full rate of oil more than once per season.
Green tip			
Scab	• Supra Captan 80 WDG or Maestro 80 DF • Flint 50 WG • Sovran • Pristine WG • Scala SC • Equal 65 WP or Syllit FL 400 • Serenade MAX	3.75 kg/ha 3.75 kg/ha 140 g/ha 240 g/ha 1–1.2 kg/ha 1 L/ha 3.25 kg/ha 5.47 L/ha 3–6 kg/ha	Start scab control early and repeat the spray if weather remains wet. **Captan, Maestro:** Do not use on d'Anjou pears. Do not use within 14 days of an application of Superior Oil. **Scala, Equal, Syllit:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. See *Managing resistance to fungicides*, page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action,* page 257. These products are locally systemic. Consult labels for information on drying time required before rain. **Sovran, Flint, Pristine:** Not recommended for use at this stage due to resistance management considerations and label restrictions on the maximum number of allowable sprays. These materials should not be used until **White bud** to **Bloom** or later, when they are likely to be most beneficial. **Equal, Syllit:** Maximum 1 application per year. **Scala:** Do not apply postbloom. **Serenade MAX:** Provides suppression rather than control of pear scab. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control, and notes on *Bacillus subtilis (Serenade ASO, Serenade MAX),* page 242.
European red mite Pear psylla	• Superior 70 Oil • Purespray Green Spray Oil 13E	20 L/1,000 L water 20 L/1,000 L water	Best applied at or near **Green tip** for mites. Use 2,000–3,000 L of water per ha. Good coverage is essential. Oil does not control rust mite. Do not apply full rate of oil more than once per season.
Pear psylla	• Movento 240 SC • Ambush 500 EC • Surround WP	365 mL/ha 400 mL/ha 50 kg/ha	**Movento:** Has slow activity; control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. Do not use after petal fall due to the possibility of fruit injury. If psylla pressure is high, use the higher labelled rate of 435 mL/ha. Do not exceed 1.83 L/ha per year. **Surround:** Begin spray program before overwintering adults are active. Make two applications at 50 kg/ha, 7 days apart, to establish a base layer. Continue applications at 7–14 day intervals. Surround may interfere with optimum bee activity. Do not apply Surround during the tight cluster to petal fall stage. See notes on *Kaolin Clay (Surround WP),* page 247.

Diseases and Insects	Products	Rate	Comments
Oriental fruit moth (OFM)	• Isomate-M Rosso • Isomate-M 100	500 dispensers/ha 250 dispensers/ha	Pheromone mating disruption products will not control other pests that may be present in the orchard. Initial OFM population must be low. Use in square or rectangular orchard blocks at least 4 ha in size. This technology may be used in pear orchards that are less than 4 ha but are adjacent to orchards of sufficient size, if both are using this technology. Apply before moth flight begins. For more information on mating disruption, see *Using Mating Disruption in Fruit Crops,* page 248 and *Using mating disruption to control oriental fruit moth (Isomate-M Rosso and Isomate-M 100),* page 249 and OMAFRA Factsheet *Mating Disruption for Management of Oriental Fruit Moth in Stone and Pome Fruit,* Order No. 04-029. **Isomate-M 100:** Make a second application 75–80 days after the first. **Isomate-M Rosso:** Provides mating disruption for up to 120 days. In crops with long field seasons, make a second application. If desired, use both an insecticide and mating disruption for managing first generation OFM (see **Petal fall**).
White bud (white petals showing on flowers)			
Scab	• Flint 50 WG • Sovran • Pristine WG • Nova 40 W • Inspire • Equal 65 WP or Syllit 400 FL • Supra Captan 80 WDG or Maestro 80 DF • Scala SC • Serenade MAX	140 g/ha 240 g/ha 1–1.2 kg/ha 340 g/ha 292 mL/ha 3.25 kg/ha 5.47 L/ha 3.75 kg/ha 3.75 kg/ha 1 L/ha 3–6 kg/ha	Start scab control early and repeat the spray at 7–10 day intervals if weather remains wet. **Flint, Sovran, Pristine, Scala, Equal, Syllit, Nova, Inspire:** To manage resistance for each of these fungicides, do not use more than two consecutive sprays then rotate to a different fungicide group unless specified below. Do not apply to sporulating lesions. See *Managing resistance to fungicides,* page 254 and Table 12-2, *Fungicide/Bactericide Groups Based on Sites of Action, page 257.* These products are locally systemic. Consult labels for information on drying time required before rain. **Sovran, Flint, Pristine:** Where disease pressure is high, use up to 360 g/ha of Sovran. Maximum four applications Sovran or Flint per season. Do not rotate among these products. **Nova, Inspire:** Do not rotate between these products. **Nova:** Apply in 500–1,000 L/water. **Captan or Maestro:** Do not use on d'Anjou pears. Do not use within 14 days of an application of Superior Oil. **Scala:** Do not apply postbloom. **Serenade MAX:** Provides suppression rather than control of pear scab. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control, and notes on *Bacillus subtilis (Serenade ASO, Serenade MAX),* page 242.
Rust mite European red mite	• Carzol SP Instapak • Kanemite 15 SC	1.1 kg/ha 2.1 L/ha	**Carzol:** Harsh on beneficial mites and honeybees. Do not use after petal fall. **Kanemite:** Not effective on rust mites.

Diseases and Insects	Products	Rate	Comments
Pear psylla	• Assail 70 WP • Calypso 480 SC • Movento 240 SC • Ambush 500 EC • Nexter	120 g/ha 290–440 mL/ha 365 mL/ha 400 mL/ha 600 g/ha	To avoid resistance problems, pyrethroids are not recommended at this stage. Refer to comments at **First cover.** **Calypso:** Apply higher rate when pest pressure is high. Apply when populations have reached economic thresholds and the majority of the population is in early instar stages. Re-apply at 7–10 day intervals if monitoring indicates populations have reached economic threshold. **Nexter:** Maximum two applications per season. There is little commercial experience with this product for psylla. **Assail:** Maximum four applications per season. **Movento:** Has slow activity; control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant / additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. Do not use when fruit is present due to the possibility of injury. If psylla pressure is high, use the higher labelled rate of 435 mL/ha. Do not exceed 1.83 L/ha per year.
Plant bugs	• Thionex 50 W	4.5 kg/ha	This spray also helps control psylla. Registration will be withdrawn in 2013. Do not use after December 31, 2012.
Codling moth (CM)	• Isomate-CM/OFM TT	200–500 dispensers/ha	Reduces mating of codling moth (CM) and oriental fruit moth (OFM). Use in square or rectangular orchard blocks at least 4 ha in size. Initial pest populations must be low for good results. Apply prior to flight of codling moth, no later than petal fall. Tie dispensers to the upper third of canopy. Use a double rate of dispensers at edges of orchards. Most orchards will require insecticides applied for one or both CM generations to avoid unacceptable levels of damage. Monitor using traps baited with high dose pheromone lures for codling moth. Product lasts for up to 150 days for CM and up to 90 days for OFM. See *Using Mating Disruption in Fruit Crops,* page 248 and *Using mating disruption to control codling moth and oriental fruit moth with twin tube (Isomate-CM/OFM TT),* page 249.
Bloom			
There are special pollination requirements for pears. See **Pollination Requirements for Fruit Crops** at *www.ontario.ca/crops.*			
DO NOT APPLY INSECTICIDES WHILE PEARS ARE IN BLOOM. SEE *BEE POISONING* ON PAGE 267.			
Fire blight	• Streptomycin 17 • Serenade MAX • Bloomtime Biological FP	600 g/1,000 L 3–6 kg/ha 375–500 g/ha	Sprays are most effective when applied dilute (high volumes of water) prior to a wetting period. Use alone for best results. Because Streptomycin 17 is UV light sensitive, it is effective for only 2–3 days. If warm, wet conditions (above 20°C) prevail, two to three sprays during bloom may be required for fire blight control. To avoid resistance, use a maximum of three sprays per season. For more information, refer to OMAFRA, *www.Ontario.ca/cropipm.* **Bloomtime and Serenade MAX:** Provide suppression rather than control of fire blight. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control. **Serenade MAX:** See notes on *Bacillus subtilis (Serenade ASO, Serenade MAX),* page 242. **Bloomtime:** Apply in a minimum of 1,000–2,000 L water/ha. Make first application at 15–20% bloom, second application at full bloom to petal fall. Product has specific handling requirements. See label for storage requirements. See also, *Pantoea agglomerans (Bloomtime Biological FD),* page 243.

Diseases and Insects	Products	Rate	Comments
Scab	• Flint 50 WG • Sovran • Pristine WG • Equal 65 WP or Syllit FL 400 • Supra Captan 80 WDG or Maestro 80 DF • Scala SC • Nova 40 W • Inspire • Serenade MAX	140 g/ha 240 g/ha 1–1.2 kg/ha 3.25 kg/ha 3.25 kg/ha 3.75 kg/ha 3.75 kg/ha 1 L/ha 340 g/ha 292 mL/ha 3–6 kg/ha	Re-apply sprays at 7–10 days intervals to provide protection for rapidly growing shoots and leaves. **Sovran, Flint, Pristine:** Do not rotate within this group. Where disease pressure is high, use up to 360 g/ha of Sovran. **Captan, Maestro:** Do not use on d'Anjou pears. **Scala:** Do not apply postbloom. **Nova, Inspire:** Do not rotate between these products. **Nova:** Apply as a foliar spray in a volume of 500–1,000 L/water. **Inspire:** For improved fruit scab control, combine Inspire Fungicide with a protectant fungicide. **Serenade MAX:** Provides suppression rather than control of pear scab. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control and notes on *Bacillus subtilis (Serenade ASO, Serenade MAX)*, page 242.
Petal fall			
Plum curculio	• Actara 25 WG • Calypso 480 SC • Clutch 50 WDG	385 g/ha 440 mL/ha 210 g/ha	**Actara:** Do not apply when bees are in the orchard. **Calypso:** Research indicates that application of Calypso at petal fall plus 3 days is the optimal timing for plum curculio. However, if monitoring indicates plum curculio is in the orchard prior to this timing, then insecticides should be applied at petal fall. **Clutch:** Make first application before populations reach damaging thresholds. If pest pressure continues, follow up with a second application 10–14 days later. If applied at the appropriate timing and high rate, Clutch may provide suppression of codling moth and oriental fruit moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control.
Pear psylla	• Agri-Mek 1.9% EC • Assail 70 WP • Actara 25 WG • Clutch 50 WDG • Calypso 480 SC • Movento 240 SC • Ambush 500 EC • Nexter	1 L/ha 120 g/ha 385 g/ha 280–420 g/ha 290–440 mL/ha 365 mL/ha 400 mL/ha 600 g/ha	**Agri-Mek:** Do not use within 14 days of a Captan or Maestro application. Apply no later than 21 days after petal fall for best results. Apply Agri-Mek with 10 L Superior Oil and a minimum of 1,000 L of water per ha, when most mites are in the nymph stage. May cause russeting to d'Anjou and other sensitive varieties. Maximum one application per season. Alternate yearly with other insecticides. Agri-Mek will not control plum curculio. **Actara:** Do not apply when bees are in the orchard. **Calypso:** Apply higher rate when pest pressure is high. Apply when populations have reached economic thresholds and the majority of the population is in early instar stages. Re-apply at 7–10 day intervals if monitoring indicates populations have reached economic threshold. **Movento:** Has slow activity; control may not be apparent for 2–3 weeks. Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. Do not use when fruit is present due to the possibility of injury. If psylla pressure is high, use the higher labelled rate of 435 mL/ha. Do not exceed 1.83 L/ha per year. **Clutch:** Make first application before populations reach damaging thresholds. If pest pressure continues, follow up with a second application 10–14 days later. If applied at the appropriate timing and high rate, Clutch may provide suppression of codling moth and oriental fruit moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. **Nexter:** There is little commercial experience with this product for psylla.

Diseases and Insects	**Products**	**Rate**	**Comments**
Obliquebanded leafroller (OBLR) Green fruitworm	• Dipel 2X DF or Foray 48BA or Bioprotec CAF • Success 480 SC or Entrust 80 W • Delegate WG • Intrepid 240 F • Altacor • Imidan 50 WP	1.125 kg/ha 2.8 L/ha 4 L/ha 182 mL/ha 109 g/ha 420 g/ha 750 mL/ha 285 g/ha 3.75 kg/ha	For overwintering OBLR apply at petal fall. Spray in orchards with historical pest problems or high pest pressure (1–2% of the terminals or buds have larvae or damage). OBLR are resistant to organophosphate insecticides in most commercial orchards. Cross-resistance to pyrethroids, Confirm and Intrepid is possible. Avoid treating sequential generations with products from the same chemical group. See *Managing resistance to insecticides and miticides*, page 255. **Dipel, Foray, Bioprotec (B.t. products):** Make two applications at 5–7 day intervals if activity of the larvae is extended. For best results when using B.t. products, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days. See *Biopesticides for Insect Control*, page 247. Place pheromone traps in orchards at petal fall to monitor OBLR adults.
Rust mite European red mite	• Carzol SP Instapak • Envidor 240 SC • Kanemite 15 SC	1.1 kg/ha 750 mL/ha 2.1 L/ha	To control rust mite and prevent russeting fruit, apply a miticide at prebloom or petal fall. Alternate miticides. **Carzol:** Is harsh on beneficial mites and honeybees. Do not apply after petal fall. **Envidor:** Works slowly, especially in cool weather. Control may not be apparent for 2–3 weeks. Apply before mite populations build up. **Kanemite:** Is not effective on rust mites.
Leaf spots Scab	Use one of the fungicides listed for scab at **Green tip.**		If wet weather persists, additional sprays will be needed for scab control before first cover. Where there is a problem, spray at petal fall and first cover.
Special spray (when monitoring indicates the need at Petal fall)			
Codling moth (first generation)	• Assail 70 WP • Calypso 480 SC • Altacor • Delegate WG • Imidan 50 WP	170 g/ha 440 mL/ha 215 g/ha 420 g/ha 3.75 kg/ha	Timing is critical for effective control. Use pheromone traps to time sprays. Apply insecticides between 83–138 DDC (base 10°C) after first sustained moth catch. See *Degree-day modeling and determining a biofix*, page 9. **Imidan, (OP insecticides):** Apply for first generation codling moth at 138 DDC. **Assail and Calypso:** Apply 1–2 days earlier at (111–138 DDC) than OP insecticides. Calypso/Assail residues last 10–14 days. Do not apply as a border spray. **Altacor and Delegate:** Apply at 138 DDC. Residues last 10–14 days. Do not apply as a border spray.

Diseases and Insects	Products	Rate	Comments
First cover			
Pear psylla	• Assail 70 WP • Actara 25 WG • Clutch 50 WDG • Calypso 480 SC • Decis 5 EC • Ripcord 400 EC or Up-Cyde 2.5 EC • Matador 120 EC or Silencer 120 EC • Ambush 500 EC or Pounce 384 EC or Perm-Up • Agri-Mek 1.9% EC • Nexter • Surround WP	120 g/ha 385 g/ha 280–420 g/ha 290–440 mL/ha 350 mL/ha 175 mL/ha 280 mL/ha 83 mL/ha 83 mL/ha 400 mL/ha 520 mL/ha 520 mL/ha 1 L/ha 600 g/ha 50 kg/ha	Apply when the majority of the population is in early instar stages. Where plum curculio is a later season problem, use one of the materials recommended at **Petal fall**. **Actara:** Do not apply when bees are in the orchard. **Calypso:** Apply higher rate when pest pressure is high. Apply when populations have reached economic thresholds and the majority of the population is in early instar stages. Re-apply at 7-10 day intervals if monitoring indicates populations have reached economic threshold. **Clutch:** Make first application before populations reach damaging thresholds. If pest pressure continues, follow up with a second application 10-14 days later. If applied at the appropriate timing and high rate, Clutch may provide suppression of codling moth and oriental fruit moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. **Decis, Ripcord, Pounce, Matador, Perm-Up, Silencer, Up-Cyde:** Apply when most of the population is in early instar stages. Resistance to these pyrethroid insecticides was widespread in the past. Resistance to these products may still be present. **Agri-Mek:** Apply no later than 21 days after petal fall. Apply with 10 L Superior Oil and a minimum of 1,000 L of water per ha. Apply when most mites are in the nymph stage. May cause russeting to d'Anjou and other sensitive varieties. Do not use oil within 14 days of a Captan or Maestro application. **Nexter:** There is little commercial experience with these products for psylla. **Surround:** See notes on *Kaolin Clay (Surround WP)*, page 247.
Scab	Use one of the fungicides listed under **Green tip.** Reduce rate of Equal to 2.25 kg/ha and Syllit to 3.65 L/ha in cover sprays. **Nova, Inspire:** For additional fruit protection, tank mix with the full rate of a protectant fungicide.		
Special spray (when monitoring indicates the need at First cover)			
Blister mite	• Sevin XLR	6.25 L/ha	
Summer sprays			
Pear psylla	• Assail 70 WP • Clutch 50 WDG • Calypso 480 SC • Decis 5 EC • Ripcord 400 EC or Up-Cyde 2.5 EC • Matador 120 EC or Silencer 120 EC • Ambush 500 EC or Pounce 384 EC or Perm-Up • Nexter • Surround WP	120 g/ha 280–420 g/ha 290–440 mL/ha 350 mL/ha 175 mL/ha 280 mL/ha 83 mL/ha 83 mL/ha 400 mL/ha 520 mL/ha 520 mL/ha 600 g/ha 50 kg/ha	Apply when majority of the population is in early instar stages. Do not exceed maximum number of applications for any product. See Table 7-9. *Products Used on Pears*, page 204. **Calypso:** Apply higher rate when pest pressure is high. Apply when populations have reached economic thresholds and the majority of the population is in early instar stages. Re-apply at 7–10 day intervals if monitoring indicates populations have reached economic threshold. **Clutch:** Make first application before populations reach damaging thresholds. If pest pressure continues, follow up with a second application 10–14 days later. If applied at the appropriate timing and high rate, Clutch may provide suppression of codling moth and oriental fruit moth. **Decis, Ripcord, Pounce, Matador, Perm-Up, Silencer, Up-Cyde:** Apply when most of the population is in early instar stages. Psylla resistance to pyrethroid insecticides may be present. **Surround:** See notes on *Kaolin Clay (Surround WP)*, page 247.

Diseases and Insects	Products	Rate	Comments
Obliquebanded leafroller (OBLR)	• Dipel 2X DF or Foray 48BA or Bioprotec CAF • Success 480 SC or Entrust 80 W • Delegate WG • Intrepid 240 F • Altacor • Imidan 50 WP	1.12 kg/ha 2.8 L/ha 4 L/ha 182 mL/ha 109 g/ha 420 g/ha 750 mL/ha 285 g/ha 3.75 kg/ha	Place pheromone traps in orchards by June to monitor adult populations. Insecticides for summer generation larvae should be applied at 240–280 DDC (base 6.1°C) after first sustained moth catch. When applied for leafroller control, these products also control other leaf-feeding caterpillars. See *Degree-day modeling and determining a biofix*, page 9. OBLR are resistant to organophosphate insecticides in most commercial apple orchards. Cross-resistance to pyrethroids, Confirm, and Intrepid is possible. Avoid treating sequential generations with the products from the same chemical group. See Table 2-12. *Insecticide and Miticide Groups Based on Sites of Action*, page 257. **Dipel, Foray, or Bioprotec:** Make two applications at 5–7 day intervals if activity of the larvae is extended. For best results acidify spray mix to below pH 7.0 and apply at dusk or on overcast days. See *Biopesticides for Insect Control*, page 247. **Delegate, Success, Entrust:** Monitor populations and re-apply as necessary on a 7–10 day schedule. Use a maximum of three applications per season. **Intrepid, Confirm:** These products provide suppression of OBLR at this timing. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. Apply a second spray 10–14 days after the first application. See label for specific timing. Use a maximum of two applications per season. **Altacor:** Be aware of the 14 days to harvest interval.
Mites	• Envidor 240 SC • Nexter • Kanemite 15 SC • Kumulus DF or Microthiol Disperss	750 mL /ha 300 g/ha 2.1 L/ha 6 kg/ha 6 kg/ha	Examine orchards for red mite and rust mite injury about July 15–20 or 10–15 days after using a pyrethroid. See Table 7-9. *Products Used on Pears*, page 204, for preharvest intervals. Alternate miticides. **Envidor:** Works slowly, especially in cool weather. Control may not be apparent for 2–3 weeks. Apply before mite populations build up. **Kanemite:** Not effective on rust mites.
Second cover			
Oriental fruit moth (OFM)	• Assail 70 WP • Calypso 480 SC • Altacor • Delegate WG • Decis 5 EC	240 g/ha 440 mL/ha 215 g/ha 420 g/ha 250 mL/ha	Products are recommended at different timings because they work best on specific life stages of the pest. Apply within the appropriate degree-days specified for best results. Monitor populations and re-apply 10–14 days later if required. See *Degree-day modeling and determining a biofix*, page 9. Alternate products from different groups to prevent the development of resistance. See Table 7-9. *Products Used on Pears*, page 204. **Assail, Calypso:** Apply before first egg hatch, 750–778 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). **Assail:** Apply in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Will also control plum curculio. Maximum four applications per season. **Altacor, Delegate, Decis:** Apply at first egg hatch, 778-833 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). Comply with the 14 days to harvest interval. **Decis:** Maximum three sprays per season. For resistance management, if more than one spray is required for this generation, use a product from the same chemical group. For subsequent generations rotate to another chemical group.
Scab	Use one of the fungicides listed under **Green tip.** Reduce rate of Equal to 2.25 kg/ha and Sylitt to 3.65 L/ha in cover sprays. Check preharvest intervals on Table 7-9. *Products Used on Pears*, page 204.		

Diseases and Insects	**Products**	**Rate**	**Comments**
Sooty blotch	• Supra Captan 80 WDG or Maestro 80 DF	3.75 kg/ha 3.75 kg/ha	Spray twice, two weeks apart. Do not use Captan or Maestro on d'Anjou pears.
	• Flint 50 WG	140 g/ha	
	• Pristine WG	600–800 g/ha	
	• Inspire	292 mL/ha	
Special sprays (when monitoring indicates the need about mid-Aug. and early Sept.)			
Check preharvest interval before spraying early maturing pears. See Table 7-9. *Products Used on Pears*, page 204.			
Codling moth (second generation)	• Assail 70 WP	170 g/ha	Do not apply as a border spray. Codling moth can infest pear as maturation and ripening begins. Bosc pears can be heavily infested and may require two preharvest sprays about 2 weeks apart. Timing is critical for effective control. Use pheromone traps to time sprays. For second generation codling moth, spray at 611 to 694 DDC (base 10°C) after first generation sustained moth catch. See *Degree-day modeling and determining a biofix*, page 9. **Assail:** Apply 1–2 days earlier than OP insecticides (639-667 DDC). Assail residues last 10–14 days. **Imidan:** Apply at 667–694 DDC. **Delegate and Altacor:** Apply at 667–694 DDC.
	• Altacor	215 g/ha	
	• Delegate WG	420 g/ha	
	• Imidan 50 WP	3.75 kg/ha	
Oriental fruit moth (OFM)	• Decis 5 EC	250 mL/ha	Products are recommended at different timings because they work best on specific life stages of the pest. Apply within the appropriate degree-days specified for best results. Monitor populations and re-apply 10–14 days later if required. See *Degree-day modeling and determining a biofix*, page 9. A spray 7–10 days prior to harvest is recommended in orchards with a history of OFM damage or adjacent to or near peaches. **Assail:** Apply before first egg hatch, 1,305–1,333 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). **Decis, Altacor, Delegate:** Apply at first egg hatch, 1,361–1,389 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). **Decis:** Maximum three sprays per season. For resistance management, if more than one spray is required for this generation, use a product from the same chemical group. For subsequent generations rotate to another chemical group.
	• Assail 70 WP	240 g/ha	
	• Altacor	215 g/ha	
	• Delegate WG	420 g/ha	
Postharvest fruit treatment			
Blue mould	• Mertect SC	500 mL/500 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. **Mertect:** For use in dip tank or drencher. Continuous agitation required. Follow label instructions. Does not control any blue mould *(Penicillium)* or grey mould *(Botrytis)*, which is resistant to benzimidazole fungicides (e.g. Benlate). **Scholar:** Scholar also controls grey mould. See label for dip and drench instructions. **Bio-Save:** Provides suppression rather than control of storage rots. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. See *Pseudomonas syringae* (Bio-Save 10 LP), page 243.
	• Scholar 230 SC	496 mL/378 L water	
	• Bio-Save 10 LP	50 g/300 L water	

Table 7-9. Products Used on Pears

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products used for control or suppression of insects and mites						
Actara 25 WG	28408	thiamethoxam	4	60 days	12 hours	2
Agri-Mek 1.9% EC	24551	abamectin	6	28 days		1 or 2 (max. 1.5 L/ha)
Altacor	28981	chlorantraniliprole	28	14 days	12 hours	3
Ambush 500 EC	14882	permethrin	3	7 days		
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours/6 days[4]	4
Bioprotec CAF	26854	*Bacillus thuringiensis*	11	1 day		
Calypso 480 SC	28429	thiacloprid	4	30 days	12 hours	3 (max. 875 mL/ha)
Carzol SP Instapak	29991	formetanate hydrochloride	1A	not after petal fall	12 days/14 days/ 19 days[1]	1
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2
Decis 5 EC	22478	deltamethrin	3	7 days		3
Delegate WG	28778	spinetoram	5	7 days	12 hours	3
Dipel 2X DF	26508	*Bacillus thuringiensis*	11	1 day		
Entrust 80 W	27825	spinosad	5	7 days		3
Envidor 240 SC	28051	spirodiclofen	23	7 days	12 hours	1
Foray 48BA	24978	*Bacillus thuringiensis*	11	1 day		
Imidan 50 WP	23006	phosmet	1B	14 days	7 days/14 days[2]	5
Intrepid 240 F	27786	methoxyfenozide	18	14 days	12 hours	2
Kanemite 15 SC	28641	acequinocyl	20B	14 days	12 hours	4.1 L/ha
Matador 120 EC	24984	lambda-cyhalothrin	3	7 days	24 hours	1
Movento 240 SC	28593	spirotetramat	23	7 days	12 hours	
Nexter	25135	pyridaben	21	25 days	24 hours	2
Perm-Up	28877	permethrin	3	7 days	12 hours	
Pounce 384 EC	16688	permethrin	3	7 days		
Purespray Green Spray Oil 13E	27666	mineral oil			12 hours	
Ripcord 400 EC	15738	cypermethrin	3	7 days		2
Sevin XLR	27876	carbaryl	1A	11 days		
Silencer 120 EC	29052	lambda-cyhalothrin	3	7 days	24 hours	3
Success 480 SC	26835	spinosad	5	7 days		3
Superior 70 Oil	9542 14981	mineral oil		use prebloom	12 hours	
Surround WP	27469	kaolin		0 days		

A blank cell indicates the information is not specified on the product label.

* Registration will be withdrawn in 2013. Do not use Thionex on pears after December 31, 2012.

[1] Re-entry period/exceptions are as follows: scouting, weeding, irrigating/ hand harvest, hand pruning training, propping/ hand thinning.

[2] Re-entry period/exceptions are as follows: re-entry/pick-your-own harvest.

[3] Depends on rate, see label.

[4] Re-entry period/exceptions are as follows: re-entry/ hand thinning.

[5] Re-entry period/exceptions are as follows: re-entry/ protected clothing required for all re-entry.

[6] Re-entry period/exceptions are as follows: re-entry/ hand harvesting/ hand thinning.

[7] Re-entry period/exceptions are as follows: re-entry/ hand labour and scouting activities/hand thinning.

Table 7-9. Products Used on Pears (cont'd)

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Thionex 50 W*	14617	endosulfan	2A	15 days	4 days	2
Up-Cyde 2.5 EC	28795	cypermethrin	3	7 days	12 hours	3
Products used for control or suppression of diseases						
Bio-Save 10 LP	29673	*Pseudomonas syringae* strain ESC-10		postharvest		
Bloomtime Biological DF	28436	*Pantoea agglomerans* strain E325		0 days	4 hours	2
Equal 65 WP	15608	dodine	M	7 days	48 hours	2[3]
Flint 50 WG	27529	trifloxystrobin	11	14 days	12 hours/4 days[4]	4
Inspire	30004	difenoconazole	3	14 days	12 hours/4 days[4]	5
Kumulus FD	18836	sulphur	M	1 day	24 hours	
Maestro 80 DF	26408	captan	M	7 days	48 hours	
Mertect SC	13975	thiabendazole	1	postharvest		
Microthiol Disperss	29487	sulphur	M	1 day	24 hours	
Nova 40 WP	22399	myclobutanil	3	14 days	When dry/ indefinitely[5]	6
Pristine WG	27985	boscalid + pyraclostrobin	7+11	5 days	When dry/5 days/ 12 days[6]	4
Scala SC	28011	pyrimethanil	9	72 days	12 hours/ 24 hours[4]	4
Scholar 230 SC	29528	fludioxonil	12	postharvest		
Serenade MAX	28549	*Bacillus subtilis*	44	0 days		
Sovran	26257	kresoxim-methyl	11	30 days	48 hours	4
Streptomycin 17	10305	streptomycin	18	30 days	24 hours/7 days/ 14 days[7]	3
Supra Captan 80 WDG	24613	captan	M	7 days	48 hours	
Syllit FL 400	28351	dodine	M	7 days	48 hours	2

A blank cell indicates the information is not specified on the product label.

* Registration will be withdrawn in 2013. Do not use Thionex on pears after December 31, 2012.

[1] Re-entry period/exceptions are as follows: scouting, weeding, irrigating/ hand harvest, hand pruning training, propping/ hand thinning.

[2] Re-entry period/exceptions are as follows: re-entry/pick-your-own harvest.

[3] Depends on rate, see label.

[4] Re-entry period/exceptions are as follows: re-entry/ hand thinning.

[5] Re-entry period/exceptions are as follows: re-entry/ protected clothing required for all re-entry.

[6] Re-entry period/exceptions are as follows: re-entry/ hand harvesting/ hand thinning.

[7] Re-entry period/exceptions are as follows: re-entry/ hand labour and scouting activities/hand thinning.

Thinning Pears

The main pear cultivars benefit from fruit thinning. The thinning of fruit is particularly beneficial during seasons of heavy fruit set or inadequate moisture. Bartlett and Bosc can set fruit in clusters of three to five fruit per spur. See notes on irrigation under *Thinning Peaches*, page 194.

- If fruit set is excessive, reduce the number of fruit per cluster to one or two. If the set on the tree is not excessive, 2–3 fruit per cluster will reach a satisfactory size without fruit thinning. To obtain large sized fruit, irrigate after fruit set, during extended dry periods in midsummer and a few weeks before harvest.

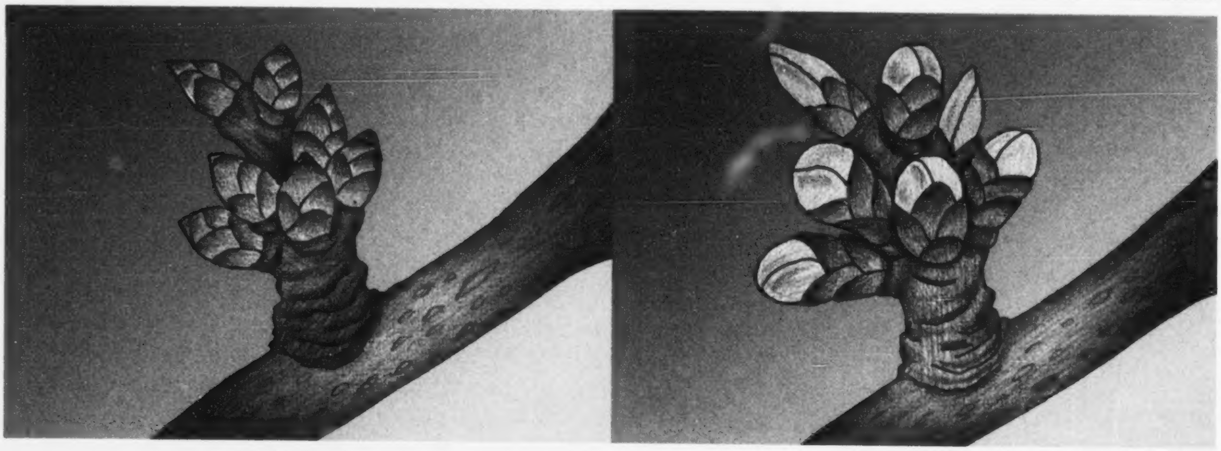
- Start thinning near the end of June drop (mid-June) when it can be determined which fruit will abort and fall on their own. Thinning at early fruit development has more benefits than late thinning.

- Thin pears on dwarfing rootstock early in the season in order to obtain a high percentage of marketable fruit and prevent limb breakage.

- De-fruit trees during the first four years of establishment. Reduce the crop to one fruit per spur, spaced 12–15 cm apart during normal years. Consider spur pruning on older trees, especially for cultivars on dwarfing rootstock. These pear trees can "runt out" if allowed to bear too heavily in years three to six. The combination of proper fruit thinning and irrigation has the most positive results on pear fruit size.

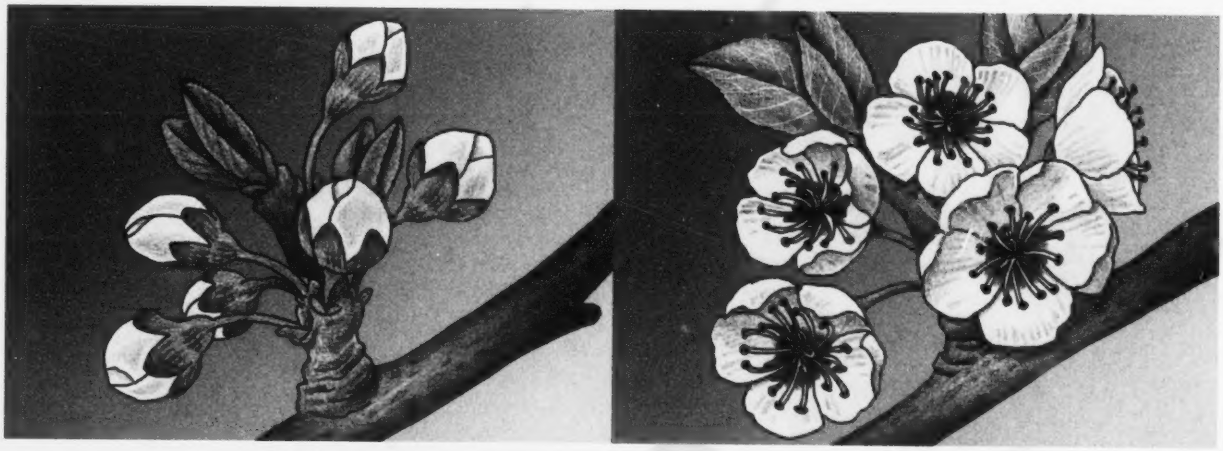
- Response of pears to chemical thinners, under Ontario conditions, is inconsistent between years. Try chemical thinning on a small scale until response can be evaluated with respect to tree vigour, cultivar and fruit size. Use either NAA (naphthaleneacetic acid) or NAD (naphthaleneacetamide) for chemical thinning. Suggested rates are: NAA at a concentration of 15–20 ppm approximately 3–6 days after petal fall, or NAD at 10 ppm, 6–9 days after petal fall, depending on tree vigour and amount of thinning desired. For specific application instructions consult the product label. See notes on NAA and NAD, page 72.

Figure 7-5. Plum and Prune Growth Stages



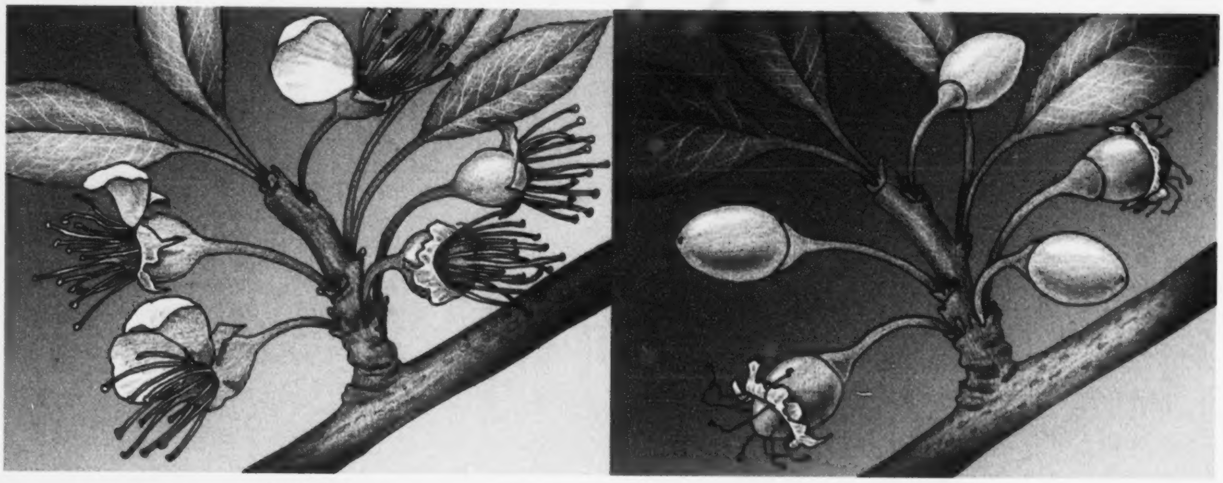
Dormant

Green Tip



Popcorn

Bloom



Petal Fall

Shuck Fall

Plum Calendar

Read the product label and follow all safety precautions. Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

Products are listed by fungicide and insecticide group. Use products from different groups to prevent pest resistance. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides,* page 253.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 7-10. *Products Used on Plums,* page 213.

Diseases and Insects	**Products**	**Rate**	**Comments**
Dormant (before bud break)			
Black knot	Prune out all black knots from commercial orchards during the dormant period before bud break. Make the cut 15 cm below the swelling. Collect and burn all prunings with knots. Knots left lying on the ground are a source of spores that start new infections. Destroy affected wild and neglected plums near the orchard. See OMAFRA Factsheet *Black Knot of Plums,* Order No. 05-017, for more information.		
Green tip (just as buds are bursting)			
European red mite Scale insects	• Superior 70 Oil • Purespray Green Spray Oil 13E	20 L/1,000 L water 20 L/1,000 L water	Spray on a calm day to improve coverage.
Popcorn (when blossoms show white)			
Brown rot	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Funginex DC • Rovral • Vangard 75 WG • Lance WDG or Cantus WDG • Pristine WG	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 2.5 L/ha 1.5 kg/ha 370 g/ha 370 g/ha 370 g/ha 750 g/ha	To help control brown rot, knock off fruit mummies when pruning. Cultivate entire orchard before bloom. Make two to three fungicide applications from early to full bloom. **Rovral, Topas, Jade, Mission, Indar, Funginex, Vangard, Lance, Cantus, Pristine:** These products are locally systemic and will penetrate petals to protect fruit from infection as blossoms starts to open. Consult labels for information on drying time required before rain. To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2, *Fungicide/Bactericide Groups Based on Sites of Action, page 257.* **Topas, Jade, Mission, Indar, Funginex:** Do not rotate among these products. **Pristine, Lance, Cantus:** Do not alternate Pristine with Lance or Cantus. **Rovral or Vangard:** No more than two applications per year.
Black knot	• Supra Captan 80 WDG or Maestro 80 DF • Indar 75 WSP • Topas or Jade or Mission 418 EC	4.5 kg/ha 4.5 kg/ha 140 g/ha 500 mL/ha 500 mL/ha 300 mL/ha	Fungicides will not provide adequate control of black knot without proper orchard sanitation (pruning, removal, and burning of black knots). Inspect all plums in early summer for new knots and those missed. Cut these out and burn them. European plums, prunes and Damsons are most susceptible. Apply fungicide sprays to protect the developing shoots between the popcorn stage (prebloom) and first cover every 3–5 days in wet weather. Spore release may be delayed in dry springs. Under these conditions extend fungicide coverage to **Second cover**. See OMAFRA Factsheet *Black Knot of Plums,* Order No. 05-017. **Topas, Jade, Mission:** Provide suppression rather than control of black knot. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control.

Diseases and Insects	Products	Rate	Comments
Consider both European and Japanese plums as self-unfruitful. Mixed plantings and insect pollinators are essential. Honeybees readily work plum blossoms.			
Bloom			
DO NOT APPLY INSECTICIDES WHILE PLUM TREES ARE IN BLOOM. SEE *BEE POISONING* ON PAGE 267.			
Brown rot (Blossom blight)	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Funginex DC • Rovral • Vangard 75 WG • Lance WDG or Cantus WDG • Pristine WG	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 2.5 L/ha 1.5 kg/ha 370 g/ha 370 g/ha 370 g/ha 750 g/ha	**Rovral, Topas, Jade, Mission, Indar, Funginex, Vangard, Lance, Cantus, Pristine:** These products are locally systemic and will penetrate petals to protect fruit from infection as blossoms starts to open Consult labels for information on drying time required before rain. To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2, *Fungicide/Bactericide Groups Based on Sites of Action, page 257.* **Topas, Jade, Mission, Indar, Funginex:** Do not rotate among these products. **Pristine, Lance, Cantus:** These products include active ingredients in the same fungicide group. Do not alternate Pristine with Lance or Cantus. **Rovral or Vangard:** No more than two applications per year.
Shuck fall (when most of the shucks are off)			
Brown rot	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Vangard 75 WG • Lance WDG or Cantus WDG • Pristine WG • Microscopic Sulphur or Microthiol Disperss • Supra Captan 80 WDG or Maestro 80 DF	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 740 g/ha 370 g/ha 370 g/ha 750 g/ha 19.5 kg/ha 12.5 kg/ha 4.5 kg/ha 4.5 kg/ha	**Topas, Jade, Mission, Indar, Vangard, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides*, page 254 and Table 12-2, *Fungicide/Bactericide Groups Based on Sites of Action, page 257.* These products are locally systemic. Consult labels for information on drying time required before rain. **Topas, Jade, Mission, Indar:** Do not rotate among these products. **Pristine, Lance, Cantus:** Do not rotate among these products. **Rovral, Vangard:** No more than two applications per year. **Microscopic Sulphur, Microthiol Disperss:** Helps control rust mites on European plums and prunes. **Captan, Maestro:** May cause leaf injury and spotting of the fruit on Stanley and Japanese plums under some circumstances.
Black knot	• Supra Captan 80 WDG or Maestro 80 DF • Indar 75 WSP	4.5 kg/ha 4.5 kg/ha 140 g/ha	Fungicides will not provide adequate control of black knot without proper orchard sanitation (pruning, removal, and burning of black knots). **Captan, Maestro:** May cause leaf injury and spotting of the fruit on Stanley and Japanese plums under some circumstances.
Oriental fruit moth (OFM)	• Assail 70 WP • Rimon 10 EC • Altacor • Delegate WG	120–240 g/ha 1.35–3.35 L/ha 285 g/ha 420 g/ha	Products are recommended at different timings because they work best on specific life stages of the pest. Apply within the appropriate degree-days specified for best results. Monitor populations and re-apply 10-14 days later if required. Where mating disruption products for OFM have been placed in the orchard, a pesticide application is generally not required at this time. **Assail, Rimon:** Apply before first egg hatch 80-120 degree-days (base 7.2°C) after first sustained moth catch in pheromone traps. **Assail:** Apply in 1,000 L of water/ha. For optimum activity, use the 240 g/ha rate. Do not apply more than once every 12 days. Will also suppress/control plum curculio. **Altacor, Delegate:** Apply at first egg hatch, 194–208 degree-days C (base 7.2°C) after biofix (first sustained moth catch). Monitor populations and re-apply 10–14 days later if required. **Altacor:** Do not exceed 645 g/ha per year.

Diseases and Insects	Products	Rate	Comments
Plum curculio	• Assail 70 WP • Clutch 50 WDG • Imidan 50 WP	240 g/ha 210 g/ha 3.75 kg/ha	**Assail:** Under high insect pressure, may provide suppression rather than control of plum curculio. **Clutch:** If applied at the appropriate timing and at 420 g/ha, Clutch may provide suppression of oriental fruit moth. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides,* page 13, for definitions of suppression and control.
Peachtree borer	• Isomate-P	250–625 dispensers/ha	**Isomate-P:** Reduces mating of peachtree borer adults. Not effective on lesser peachtree borer. Initial population must be low for good results. Use in square or rectangular orchard blocks at least 4 ha in size; larger blocks are preferred. Apply pheromone dispensers before peachtree borer flight begins in the spring. The dispenser is designed to last an entire season, so early placement (shuck-split or earlier) will not reduce effectiveness. Attach the dispensers onto branches about the mid-point of the tree. Apply at least 250 dispensers per ha for low pressure sites and up to 625 dispensers per ha for high pressure sites. In addition to mating disruption, an insecticide for peachtree borer may be needed in high pressure sites. Populations are generally reduced over time where mating disruption is used for several seasons. For more information, see *Using Mating Disruption in Fruit Crops,* page 248.
First cover (12 days after Shuck fall)			
Brown rot Leaf spot Black knot	Use one of the fungicides listed under **Shuck fall.**		**Captan, Maestro:** May cause leaf injury and spotting on the fruit of Stanley and Japanese plums under some circumstances.
Plum curculio	Use one of the insecticides listed under **Shuck fall.**		
Second cover			
Check preharvest interval before spraying early maturing plums. See Table 7-10. *Products Used on Plums,* page 213.			
Brown rot	• Topas or Jade or Mission 418 EC • Indar 75 WSP • Vangard 75 WG • Lance WDG or Cantus WDG • Pristine WG • Microscopic Sulphur • Microthiol Disperss • Supra Captan 80 WDG or Maestro 80 DF	500 mL/ha 500 mL/ha 300 mL/ha 140 g/ha 740 g/ha 370 g/ha 370 g/ha 750 g/ha 19.5 kg/ha 12.5 kg/ha 4.5 kg/ha 4.5 kg/ha	**Topas, Jade, Mission, Indar, Vangard, Lance, Cantus, Pristine:** To manage resistance for each of these fungicides, rotate to a different fungicide group for each spray. Do not apply to sporulating lesions. See *Managing resistance to fungicides,* page 254 and Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action,* page 257. These products are locally systemic. Consult labels for information on drying time required before rain. During wet weather repeat applications between pickings. Comply with preharvest intervals in Table 7-10. *Products Used on Plums,* page 213. **Topas, Jade, Mission:** No more than two applications in the three weeks prior to harvest. **Pristine, Lance or Cantus:** Do not alternate Pristine with Lance or Cantus.

Diseases and Insects	Products	Rate	Comments
Oriental fruit moth (OFM)	• Rimon 10 EC • Assail 70 WP • Altacor • Delegate WG	1.35–3.35 L/ha 120–240 g/ha 215–285 g/ha 420 g/ha	Spray all varieties. This generation may require two insecticide sprays. Products are recommended at different timings because they work best on specific life stages of the pest. Apply within the appropriate degree-days specified for best results. Monitor populations and re-apply 10–14 days later if required. Check the harvest dates of early varieties and do not spray within the preharvest interval. **Rimon:** Apply before peak egg laying 555-583 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). **Assail:** Apply before first egg hatch, 583-611 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). For optimum activity, use the 240 g/ha rate. Apply in a minimum spray volume of 1,000 L/ha. Do not apply more than once every 12 days. Will also control plum curculio. **Altacor, Delegate :** Apply at first egg hatch, 640-670 degree-days C (base 7.2°C) after biofix (first sustained moth catch, first generation). Monitor populations and re-apply 10–14 days later if required. Check the harvest dates of early varieties and do not spray within 10 days of harvest. **Altacor:** Do not exceed 645 g/ha per year.
Prepick			
Check preharvest interval before. See Table 7-10. *Products Used on Plums*, page 213.			
Brown rot	Use one of the fungicides listed under **Second cover.**		
Oriental fruit moth	Use one of the insecticides listed under **Second cover.**		
Special sprays (when monitoring indicates the need)			
Aphids	• Movento 240 SC • Clutch 50 WDG • Beleaf 50 SG • Diazinon 50 WSP • Purespray Green Spray Oil 13E	365 mL/ha 140–210 g/ha 120–160 g/ha 1 kg/1,000 L water 10 L/1,000 L water	Apply only if aphids are a problem. Very thorough coverage and calm warm conditions are needed for good control. **Movento:** Most effective on young stages of aphids. Has slow activity; control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary 2 weeks later. Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v. See label for further details. Do not tank-mix with sulphur. **Purespray Green Spray Oil 13E:** Provides suppression of aphids. See Table 2-6. *Efficacy Ratings for Insecticides, Miticides and Fungicides*, page 13, for definitions of suppression and control. Summer oils can cause crop injury, depending on rate, cultivar, weather conditions, and recent pesticide applications. Do not apply less than 1,000 L water/ha (1% solution). Not all varieties have been tested for tolerance, so spray a small area of each variety to confirm tolerance prior to spraying the whole field. Do not apply within 14 days of Captan or Maestro, or products containing sulphur. Do not apply within 48 hours of freezing temperatures. Do not apply when temperatures are very high (above 25°C) or to crops under moisture stress. Do not apply just prior to rain. Read the label carefully for other precautions. See notes on *Mineral oil (Purespray Green Spray Oil 13E)*, page 252.
Apple maggot	• Diazinon 50 WSP • Imidan 50 WP	1 kg/1,000 L water 3.75 kg/ha	If apple maggot has been a problem on blue plums and prunes, apply 2–3 sprays during July and August.
Peachtree borer Lesser peachtree borer	• Thionex 50 W • Sevin XLR	1.5 kg/1,000 L water 6.25 L/ha	Apply 3 sprays, three weeks apart. Apply first spray 10 days after first adult catch in pheromone traps. Direct these sprays with a handgun to cover trunk and scaffold limbs thoroughly. Check preharvest intervals and do not spray if fruit is to be harvested during this period.

Diseases and Insects	Products	Rate	Comments
Obliquebanded leafroller (OBLR)	• Success 480 SC or Entrust 80 W • Delegate WG • Altacor • Rimon 10 EC	182 mL/ha 109 g/ha 420 g/ha 285 g/ha 1.35–3.35 L/ha	For OBLR summer generations, apply at 240–280 degree-days C (base 6.1°C) after biofix (first sustained moth catch). Comply with the 14 days to harvest interval. **Altacor:** Do not exceed 645 g/ha per year.
Postharvest fruit treatment			
Blue mould Grey mould Brown rot Rhizopus rot	• Scholar 230 SC	496 mL/378 L water	Postharvest treatment may be necessary during wet harvest seasons. These treatments will prolong storage time while providing control of postharvest diseases. See label for dip and drench instructions. **Scholar:** Should not be used on plums intended for processing into prunes.

Notes on Plums

Heat spot

High temperatures may cause purplish spots on plum and prune fruits that exude clear gum. These spots develop about 5–8 days after a period of hot weather. Summer cover crops and mulch help to reduce this physiological condition.

To reduce this disorder on prunes, spray with 4 kg of calcium chloride in 1,000 L of water during the period from early July to mid-August. Apply three sprays, 10–12 days apart. See notes on *Calcium (Ca)* for plums, page 164.

Thinning Plums

In recent years, the market demand for larger fruit has placed more importance on fruit thinning, pruning and irrigation. Japanese plums require systematic fruit thinning; otherwise fruit size will be small and biennial cropping will ensue. European plums grown for fresh market also require thinning in the years of heavy fruit set. Inadequate fruit thinning results in production of under-sized plums and, at times, fruit ripening on overloaded trees will be delayed. Irrigation is important to obtain large-sized fruit. See notes on irrigation under *Thinning Peaches,* page 194. Start thinning near the end of June drop in early to mid-June when it can be determined which fruit will abort and fall on their own. Thinning at early fruit development has more benefits than late thinning.

Fruit size thinning is preferred to conventional space thinning. Size thinning selectively removes small, weak, blemished or diseased fruit regardless of spacing of the fruits on the branches. The end result should be proper sizing of the fruit remaining on the tree.

Table 7-10. Products Used on Plums

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between the application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season (on label)
Products used for control or suppression of insects and mites						
Altacor	28981	chlorantraniliprole	28	1 day	12 hours	3
Assail 70 WP	27128	acetamiprid	4	7 days	12 hours/6 days[1]	4
Beleaf 50 SG	29796	flonicamid	9	14 days	12 hours/48 hours[1]	3
Clutch 50 WDG	29382	clothianidin	4A	7 days	12 hours	2
Delegate WG	28778	spinetoram	5	3 days	12 hours	3
Diazinon 50 WSP	29976	diazinon	1B	10 days	4 days	
Entrust 80 W	27825	spinosad	5	7 days		3
Imidan 50 WP	23006	phosmet	1B	14 days	7 days/14 days[2]	3
Movento 240 SC	28593	spirotetramat	23	7 days	12 hours	
Purespray Green Spray Oil 13E	27666	mineral oil			12 hours	
Rimon 10 EC	28881	novaluron	15	14 days	12 hours	3
Sevin XLR	27876	carbaryl	1A	2 days		
Success 480 SC	26835	spinosad	5	7 days		3
Superior 70 Oil	9542 14981	mineral oil		use prebloom	12 hours	
Thionex 50 W	14617	endosulfan	2A	18 days	7 days/20 days[1]	3
Products used for control or suppression of diseases						
Cantus WDG	30141	boscalid	7	0 days	12 hours	5
Funginex DC	27686	triforine	3	do not apply after bloom	48 hours	3
Indar 75 WSP	27294	fenbuconazole	3	1 day	12 hours	7
Jade	24030	propiconazole	3	3 days	72 hours	5[3]
Lance WDG	27495	boscalid	7	0 days	12 hours	5
Maestro 80 DF	26408	captan	M	2 days	48 hours	
Microscopic Sulphur	14653	sulphur	M	1 day	24 hours	
Microthiol Disperss	29487	sulphur	M	1 day	24 hours	
Mission 418 EC	28016	propiconazole	3	3 days	72 hours	5[3]
Pristine WG	27985	boscalid + pyraclostrobin	7+11	0 days	When dry/ 24 hours/10 days[4]	5
Rovral	15213	iprodione	2	1 day	12 hours	
Scholar 230 SC	29528	fludioxonil	12	postharvest		
Supra Captan 80 WDG	24613	captan	M	2 days	48 hours	
Topas	30163	propiconazole	3	3 days	72 hours	5[3]
Vangard 75 WG	25509	cyprodinil	9	2 days	72 hours	4

A blank cell indicates the information is not specified on the product label.

[1] Re-entry period/exceptions are as follows: re-entry/hand thinning.

[2] Re-entry period/exceptions are as follows: re-entry/pick-your-own harvest.

[3] No more than two applications in the 3 weeks prior to harvest.

[4] Re-entry period/exceptions are as follows: re-entry/ hand harvest, hand thinning.

Notes on Fungicides for Tender Fruit

Table 7-11. Activity of Fungicides on Tender Fruit Diseases

Ratings in shaded cells indicate the pest is listed on the product label for control or suppression. Use fungicides only for diseases listed on the product label for the crop. Where ratings are not in shaded cells, some activity against the disease is anticipated, but this use is not on the product label. Consult the label for more information. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

												Registered for use on:				
Group	**Product name**	**Brown rot blossom blight**	**Brown rot fruit phase**	**Peach scab**	**Peach leaf curl**	**Bacterial canker/spot**	**Powdery mildew**	**Rhizopus rot**	**Cherry leaf spot**	**Black knot**	**Pear scab**	**Apricots**	**Cherries**	**Peaches**	**Plums**	**Pears**
M	Copper Spray	0	0	0	++	++	0	0	0	0	+		✓	✓		
M	Guardsman Copper Oxychloride	0	0	0	++	++	0	0	0	0	+		✓	✓		
M	Kumulus DF	++	+	+++	NA	NA	++	0	+	+	+		✓	✓	✓	✓
M	Microscopic Sulphur	++	+	+++	NA	NA	++	0	+	+	+		✓	✓	✓	✓
M	Microthiol Disperss	++	+	+++	NA	NA	++	0	+	+	+		✓	✓	✓	✓
M	Ferbam 76 WDG	0	0		++++	NA	0	NA	++	0	+	✓	✓	✓	✓	✓
M	Captan 80 WDG	+++	+++	++++	+++	NA	0	+	+++	++	+++	✓	✓	✓		✓
M	Maestro 80 DF	+++	+++	++++	+++	NA	0	+	+++	++	+++	✓	✓	✓		✓
M	Bravo 500	+++	NA	++++	++++	NA	0	NA	++++	++++	NA		✓	✓		
M	Echo 720	+++	NA	++++	++++	NA	0	NA	++++	++++	NA		✓	✓		
M	Purespray Green Spray Oil 13E	0	0	0	0	0	+++	0	0	0	0	✓	✓	✓	✓	
M	Equal 65 MP	NA	NA	NA	NA	NA	NA	NA	+++	NA	+++					✓
M	Syllit FL 400	NA	NA	NA	NA	NA	NA	NA	+++	NA	+++					✓
2	Rovral	++++	++++	0	NA	NA	0	++	++	0	NA	✓	✓	✓	✓	
3	Funginex DC	+++	NA	0	0	NA	+++	NA	+++	0	NA		✓	✓	✓	
3	Indar 75 WSP	++++	++++	+++	NA	NA	+++	0	+++	++	NA	✓	✓	✓	✓	
3	Inspire	NA	NA	NA	NA	NA	NA	NA	NA	NA	+++					✓
3	Jade	++++	++++	+++	NA	NA	+++	++++	+++	++	NA	✓	✓	✓	✓	✓
3	Nova 40 W	+	NA		NA	NA	++++	0	+++	0	+++		✓	✓		✓
3	Topas	++++	++++	+++	NA	NA	+++	++++	+++	++	NA	✓	✓	✓	✓	
3	Mission 418 EC	++++	++++	+++	NA	NA	+++	++++	+++	++	NA	✓	✓	✓	✓	
7	Cantus WDG	++++	++++		NA	NA	++	0			NA	✓	✓	✓	✓	
7	Lance WDG	++++	++++		NA	NA	++	0			NA	✓	✓	✓	✓	
7&11	Pristine WG	++++	++++	++++	NA	NA	++	++++	++++		+++	✓	✓	✓	✓	✓
11	Flint 50 WG								++++		+++		✓			✓
11	Sovran								++++		+++					✓
9	Vangard 75 WG	+++	+++		NA	NA	0	+++	NA		++	✓		✓	✓	✓
9	Scala SC	NA	NA	NA	NA	NA	NA	NA	NA	NA	++				✓	✓
11	Cabrio EG	++	++		NA	NA	++++	++++	++++	0	NA	✓	✓	✓		
12	Scholar 230 SC	NA	++++		NA	NA	NA	++++	NA	NA		✓	✓	✓	✓	
13	Quintec	0	0	0	0	0	+++	0	0	0	0	✓	✓	✓	✓	
17	Elevate 50 WDG	+++	+++		0	0	0	0	0	0			✓	✓		

✓ Registered on the crop. NA = Not used at this timing for this pest.
Legend: 0 = Not effective; + = Slight effect; ++ = Fair; +++ = Good; ++++ = Very good; Blank Cell = Unknown.
Source: Various US extension publications and Plant Disease Management Reports (APS).

Table 7-12. Activity of Insecticides and Miticides on Tender Fruit Pests

Ratings in shaded cells indicate the pest is listed on the product label for control or suppression. Use insecticides only for insects listed on the product label for the crop and for the insect. Where ratings are not in shaded cells, some activity against this insect is anticipated, but this use is not on the product label. Consult the label for more information. The information provided in this table is based on information from other areas. It is intended to assist the grower in choosing the best insecticide for control of pests listed on the product label, while managing resistance and avoiding unnecessary sprays for non-target pests. Efficacy can be affected by rate of the product.

											Registered for use on:				
Product name	**Oriental fruit moth**	**Plum curculio**	**Tarnished plant bug**	**Oblique banded leafroller**	**Japanese beetle**	**Aphids**	**Cherry fruit fly**	**Mites**	**Pear psylla**	**Codling moth**	**Apricots**	**Cherries**	**Peaches**	**Plums**	**Pears**
Actara 25 WG	0	+++	+++	0	++	+++ gpa		0	++++	0					✓
Admire 240 F	0	0	+				+++	0				✓	✓		
AgriMek 1.9% EC									++++						✓
Altacor	++++	+		++++						++++	✓	✓	✓	✓	✓
Ambush 500 EC	++++	++	+++	++++	+++		++		+++				✓	✓	✓
Apollo SC								+++ ES					✓		✓
Assail 70 WP	++++	+ to ++	++	+	++	++++	++		+++	+++	✓	✓	✓	✓	✓
Beleaf 50 SG			++			+++					✓	✓	✓	✓	✓
Bioprotec CAF				+++						+	✓	✓	✓	✓	✓
Calypso 480 SC	+++	+++	+++						+++	+++					✓
Carzol SP Instapak								+++ tssm ++++ erm					✓		✓
Clutch 50 WDG	+	+++				++++			+++	+	✓	✓	✓	✓	✓
Decis 5 EC	+++		+++						++++	+++			✓		✓
Delegate WG	++++	++		++++					++++	+++	✓	✓	✓	✓	✓
Diazinon 50 WSP	+++		+++	++		++	++	++ bm	++	++	✓	✓	✓	✓	✓
Dipel 2X DF	+			+++						+	✓	✓	✓	✓	✓
Entrust 80 W	+			+++			+++			+	✓	✓	✓	✓	✓
Envidor 240 SC								++++			✓	✓	✓	✓	✓
Foray 48 BA				+++ ES											✓
GF-120 NF							+++					✓			
Imidan 50 WP	+++	++++	++	++	+++	+	++		+	+++R		✓s	✓	✓	✓
Intrepid 240 F	+++ 1st			+++								✓			✓
Kanemite 15 SC								++++							✓
Lorsban 50 W	++ 1st		++++										✓		
Matador 120 EC	+++	++	+++			+++			++	+++		✓	✓	✓	✓
Movento 240 SC						++++			++++		✓	✓	✓	✓	✓
Nexter								+++ to ++++	++		✓	✓	✓		✓
Perm-Up	++++	++	++	++++	+++		++		+++	+++			✓	✓	✓
Pounce 384 EC	++++	++	++	++++	+++		++		+++	+++			✓	✓	✓
Purespray Green Spray Oil 13E						++		++++			✓	✓	✓	✓	✓

✓ Registered on the crop. NA = Not used at this timing for this pest.

Legend: 0 = Not effective; + = Slight effect/suppression; ++ = Fair; +++ = Good; ++++ = Very good; Blank cell = Unknown.

Source: Various US extension publications and Plant Disease Management Reports (APS).

ES = Early season application; ERM = European red mite; TSSM = Two-spotted spider mite; bm = Blister mite; s = Sour cherry only; 1st = First generation only; R = Resistance detected in Ontario; gpa = Green peach aphid; ow = Overwintering generation.

Table 7-12. Activity of Insecticides and Miticides on Tender Fruit Pests (cont'd)

Product name	Oriental fruit moth	Plum curculio	Tarnished plant bug	Oblique banded leafroller	Japanese beetle	Aphids	Cherry fruit fly	Mites	Pear pyslla	Codling moth	Registered for use on: Apricots	Cherries	Peaches	Plums	Pears
Rimon 10 EC	++++		++++							++++	✓	✓	✓	✓	
Ripcord 400 EC	+++	+++	+++						+++	++			✓		✓
Sevin XLR	+++	++	++	+	++++	+ gpa	++		++	++	✓	✓	✓	✓	✓
Silencer 120 EC	+++	+++	+++	++++		++	++		+++	+++		✓	✓	✓	✓
Success 480 SC	+			+++						+	✓	✓	✓	✓	✓
Superior 70 Oil								++++	++		✓	✓s	✓	✓	✓
Surround WP	+	++		++ ow	+				++	+					✓
Thionex 50 W		++	++		++	++	++		+++	++	✓	✓	✓	✓	
Up-Cyde 2.5 EC	+++	+++	+++						+++	+++			✓	✓	✓

✓ Registered on the crop. NA = Not used at this timing for this pest.

Legend: 0 = Not effective; + = Slight effect/suppression; ++ = Fair; +++ = Good; ++++ = Very good; Blank cell = Unknown.

Source: Various US extension publications and Plant Disease Management Reports (APS).

ES = Early season application; ERM = European red mite; TSSM = Two-spotted spider mite; bm = Blister mite; s = Sour cherry only; 1st = First generation only;
R = Resistance detected in Ontario; gpa = Green peach aphid; ow = Overwintering generation.

8. Tree Nuts

Walnut Calendar

Read the label and follow all safety precautions.

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount per 1,000 L and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point.

For preharvest interval, re-entry period, maximum number of applicationsand chemical group, see Table 8-1. *Products Used on Tree Nuts,* page 222.

Diseases and Insects	Products	Rate	Comments
Prebloom			
Leafrollers	• Dipel 2X DF • Surround WP • Altacor	1.12 kg/ha 50 kg/ ha 145–285 g/ha	**Dipel:** Apply when small larvae are present. Apply in 600–800 L water/ha using an orchard air-blast sprayer. Repeat in 7–10 days or after bloom if populations are large. Although Dipel is not toxic to bees, avoid application during bloom. Use 1.6 kg/ha for large or mature trees. See *Biopesticides for Insect Control,* page 247, and notes on *Bacillus thuringiensis* var. *kurstaki,* page 247. **Surround:** Reduces damage due to leafrollers. Apply in 1,000 L water/ha. Apply just prior to green tip or when larvae are first seen. Make a first application before larvae roll up into leaves and a second application 7 days later. Repeat at 7–14 day intervals as subsequent generations emerge. See notes on *Kaolin Clay (Surround WP),* page 247. **Altacor:** Apply when overwintering larvae become active in the spring. Repeat if necessary, approximately 10 days later. For summer generations, monitor adult moth flight and apply at first egg hatch (170–240 degree-days Celsius after the first sustained moth catch). Repeat if necessary, approximately 7 days later. For resistance management, rotate with Dipel or Surround.
Aphids	• Movento 240 SC • Opal Insecticidal Soap	365 mL/ha 20 L/1,000 L water	Most effective on young stages of aphids. **Movento:** Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v (2 L/1,000 L). See label for further details. Has slow activity. Control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary. Allow at least 14 days between applications. Thorough coverage is necessary for good control of aphid and scale pests. See label for recommendations to prevent spray drift. Do not apply more than 1.58 L/ha/year. **Opal:** Apply 700–1,900 L of spray solution/ha. Spray to wetting but minimize runoff. Begin applications when pests first appear. Repeat every 1–3 weeks as needed. Apply Opal no more than 3 times; additional applications will increase the risk of plant injury. Avoid application in direct sunlight.
San Jose scale	• Movento 240 SC • Opal Insecticidal Soap	585 mL/ha 20 L/1,000 L water	Monitor scaffold branches for adult scale. Spray when crawlers are active. Contact a consultant for assistance with timing sprays. See comments for aphids above.
Mites	• Opal Insecticidal Soap	20 L/1,000 L water	See comments on using Opal for aphids, above.

Diseases and Insects	Products	Rate	Comments
Codling moth	• Isomate-CM/OFM TT • Altacor	500 dispensers/ha 145–215 g/ha	Codling moth is not normally a serious problem in commercial walnuts. Apply controls if there is a history of codling moth damage. **Isomate-CM/OFM TT:** Reduces mating of codling moth (CM). Initial CM populations must be low for good results. Apply to blocks of walnut or walnut/apple that are at least 4 ha in size. Timing is critical for effective control. Apply pheromone dispensers to the upper third of the tree canopy, before first flight of CM, no later than petal fall of apples. Double the rate of dispensers at the edges of orchards. This product lasts for up to 150 days for CM. See *Using mating disruption to control codling moth and oriental fruit moth with twin tube (Isomate CM/OFM TT)*, page 249. **Altacor:** For control of 1st-generation codling moth, apply before first egg hatch (80–110 degree-days Celsius after first sustained moth catch). Reapply 10–14 days later if required. Use high rate when pest pressure is high. Use no more than 3 applications per season.
1st pistillate flower			
Butternut curculio	• Surround WP	50 kg/ha	Apply when visual inspection shows adult feeding and egg laying scars on new flower shoots. See notes on *Kaolin Clay (Surround WP)*, page 247.
Aphids	• Movento 240 SC • Opal Insecticidal Soap	365 mL/ha 20 L/1,000 L water	See comments on using these products for aphids **Prebloom.**
San Jose scale	• Movento 240 SC • Opal Insecticidal Soap	585 mL/ha 20 L/1,000 L water	See comments on using these products for San Jose scale at **Prebloom.**
Walnut blight	• Copper Spray	4 kg/1,000 L	Apply in sufficient water to ensure complete coverage.
Summer sprays			
Husk maggot	• Surround WP • GF-120 NF	50 kg/ha 1.5 L/6 L water/ha	**Surround:** Apply when sticky traps show adult activity, typically August to mid September. See notes on *Kaolin Clay (Surround WP)*, page 247. **GF-120:** This is a bait formulation that requires large droplet size (4–6 mm); specialized application equipment may be needed. Begin applications when first adult flies are found in sticky traps. Repeat weekly while flies are present. GF-120 will lose effectiveness if exposed to rain or overhead irrigation. Under extreme pest pressure, this product may provide only suppression of walnut husk fly. Apply 7.5 L of spray solution/ha.
Mites	• Acramite 50 WS	568 g/ha	Apply as soon as scouting indicates mites are present on foliage. Complete coverage of all affected plant parts (upper and lower surfaces) is necessary for effective control. Rate is sufficient to control two-spotted spider mite, the most common mite species present on tree nuts. If European red mite is present, apply higher labelled rate (851 g/ha).
Aphids	• Movento 240 SC • Opal Insecticidal Soap	365 mL/ha 20 L/1,000 L water	See comments on using these products for aphids **Prebloom.**
Walnut blight	• Copper Spray	4 kg/1,000 L water	Apply in sufficient water to ensure complete coverage. Apply monthly until husks split, but not after husks split. Do not apply more than four times per season. Do not apply within 40 days of harvest.

Pecan and Sweet Chestnut Calendar

Read the label and follow all safety precautions.
For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 8-1. *Products Used on Tree Nuts*, page 222.

Diseases and Insects	Products	Rate	Comments
Prebloom			
Leafrollers	• Dipel 2X DF • Altacor	1.12 kg/ha 145–285 g/ha	**Dipel:** Apply when small larvae are present. Apply in 600–800 L/ha using an orchard air-blast sprayer. Repeat in 7–10 days or after bloom if populations are large. Although Dipel is not toxic to bees, avoid application during bloom. Use 1.6 kg/ha for large or mature trees. See *Biopesticides for Insect Control*, page 247, and notes on *Bacillus thuringiensis* var. *kurstaki*, page 247. **Altacor:** Apply when overwintering larvae become active in the spring. Repeat if necessary, approximately 10 days later. For summer generations, monitor adult moth flight and apply at first egg hatch (170–240 degree-days Celsius after the first sustained moth catch). Repeat if necessary, approximately 7 days later. Use no more than 3 applications per season. For resistance management, rotate with Dipel.
Aphids	• Movento 240 SC • Opal Insecticidal Soap	365 mL/ha 20 L/1,000 L water	Begin monitoring in mid-spring for young nymphs. Aphids are generally controlled by natural predation. **Movento:** Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v (2 L/1,000 L). See label for further details. Has slow activity. Control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary. Allow at least 14 days between applications. Thorough coverage is necessary for good control of aphid and scale pests. See label for recommendations to prevent spray drift. Do not apply more than 1.58 L/ha/year. **Opal:** Apply 700–1,900 L of spray solution/ha. Spray to wetting but minimize runoff. Begin applications when pests first appear. Repeat every 1–3 weeks as needed. Apply Opal no more than 3 times. Additional applications will increase the risk of plant injury. Avoid application in direct sunlight.
Leafhoppers	• Surround WP	50 kg/ha	**Surround** reduces damage due to leafhoppers. Use on sweet chestnut only, primarily on younger, newly establishing orchards. Larger mature trees are generally not significantly affected by leafhopper. Monitor for young nymphs in beginning mid to late spring. Apply Surround WP to young trees where leafhopper populations are high. Apply in 1,000 L water/ha, beginning when insects first appear. Repeat at 7–14 day intervals. See notes on *Kaolin Clay (Surround WP)*, page 247.
San Jose scale	• Movento 240 SC	585 mL/ha	Monitor scaffold branches for adult scale. Scale insects are rarely a problem in chestnuts or pecans. See comments on Movento at **Prebloom.**
Mites	• Opal Insecticidal Soap	20 L/1,000 L water	See comments on Opal for aphids at **Prebloom.**
1st pistillate flower			
Butternut curculio	• Surround WP	50 kg/ha	Apply when visual inspection shows adult feeding and egg laying scars on new flower shoots. See notes on *Kaolin Clay (Surround WP)*, page 247.
Aphids	• Movento 240 SC • Opal Insecticidal Soap	365 mL/ha 20 L/1,000 L water	See comments on aphids at **Prebloom.**
Leafhoppers	• Surround WP	50 kg/ha	See comments on leafhoppers at **Prebloom.**
San Jose scale	• Movento 240 SC	585 mL/ha	Monitor scaffold branches for adult scale. Scale insects are rarely a problem in chestnuts or pecans.

Diseases and Insects	Products	Rate	Comments
Summer sprays			
Aphids	• Movento 240 SC • Opal Insecticidal Soap	365 mL/ha 20 L/1,000 L water	See comments on aphids at **Prebloom.**
Mites	• Acramite 50 WS	568 g/ha	Apply as soon as scouting indicates mites are present on foliage. Complete coverage of all affected plant parts (upper and lower surfaces) is necessary for effective control. Rate is sufficient to control two-spotted spider mite, the most common species present on tree nuts. If European red mite is present, apply higher labelled rate (851 g/ha).
Leafhoppers	• Surround WP	50 kg/ha	See comments on leafhoppers at **Prebloom.**
Chestnut blight	There are currently no fungicides registered to control chestnut blight infection. Monitor for orange-coloured cankers on branches and main trunk and prune infected wood where feasible. Remove prunings from the orchard to prevent spread of spores.		
Postharvest			
Small chestnut weevil Large chestnut weevil	There currently are no insecticides registered for control of chestnut weevil in nut trees. Monitor a sample of harvested crop (e.g. 50 nuts) by cutting open nuts and inspecting the nutmeat for signs of weevil larvae. Pick up all fallen nuts from the orchard floor to prevent over-wintering of weevils.		

Filbert/Hazelnut Calendar

Read the label and follow all safety precautions.

For preharvest interval, re-entry period, maximum number of applications and chemical group, see Table 8-1. *Products Used on Tree Nuts,* page 222.

Diseases and Insects	Products	Amount	Comments
Bud break (up to ¼ inch vegetative growth)			
Eastern filbert blight	• Guardsman Copper Oxychloride 50, or Copper Spray • Flint 50 WG	3 kg/ha 3 kg/ha 140–280 g/ha	**Copper products:** Apply during the spring at bud swell and repeat at 10–14 day intervals. Use no more than three applications per year. Use 3 kg/ha on small trees and up to 9 kg/ha on large trees. May be applied up to one day before harvest. **Flint:** Use 140 g/ha on small trees or up to 280 g/ha on larger trees. Begin applications at bud break and continue as needed on a 14-day interval. Make no more than 2 consecutive applications, and then choose copper fungicides for the next two applications. Use a maximum of 4 applications per year. Avoid drift, especially to Concord grapes.
Early Spring (> ¼ inch vegetative growth)			
Eastern filbert blight	Apply one of the fungicides listed for this disease under **Bud Break.** Some products have limited numbers of applications per year.		
Leafrollers	• Dipel 2X DF • Surround WP • Altacor	1.12 kg/ha 50 kg/ha 145–285 g/ha	**Dipel:** Apply when small larvae are present. Apply in 600–800 L/ha using an orchard air-blast sprayer. Repeat in 7–10 days or after bloom if populations are large. Although Dipel is not toxic to bees, avoid application during bloom. Use 1.6 kg/ha for large or mature trees. This product may also provide control of other spring feeding caterpillars. **Surround:** Reduces damage due to leafrollers. Apply in 1,000 L water/ha. Apply just prior to green tip stage or when larvae are first seen. Make a first application before larvae roll up into leaves and a second application 7 days later. Repeat at 7–14 day intervals as subsequent generations emerge. See notes on *Kaolin Clay (Surround WP),* page 247. **Altacor:** Apply when overwintering larvae become active in the spring. Repeat if necessary, approximately 10 days later. For summer generations, monitor adult moth flight and apply at first egg hatch (170–240 degree-days Celsius after the first sustained moth catch). Repeat if necessary, approximately 7 days later. For resistance management, rotate with Dipel or Surround.

Diseases and Insects	Products	Amount	Comments
Aphids	• Lagon 480 E or Cygon 480-AG • Movento 240 SC • Opal Insecticidal Soap	5 L/ha 5 L/ha 365 mL/ha 20 L/1,000 L water	**Lagon, Cygon:** Apply primarily on younger trees when aphids appear. Do not apply within 45 days of harvest. Use no more than one application per year. **Movento:** Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v (2 L/1,000 L). See label for further details. Has slow activity. Control may not be apparent for 2–3 weeks. Under high pressure a second application may be necessary. Allow at least 14 days between applications. Thorough coverage is necessary for good control of aphid and scale pests. See label for recommendations to prevent spray drift. Do not apply more than 1.58 L/ha/year. **Opal:** Apply 700–1,900 L of spray solution/ha. Spray to wetting but minimize runoff. Begin applications when pests first appear. Repeat every 1–3 weeks as needed. Use no more than 3 consecutive applications. Additional applications will increase the risk of plant injury. Avoid application in direct sunlight.
Mites	• Opal Insecticidal Soap	20 L/1,000 L water	Monitor for young nymph stages using a 10× hand lens. Treat in late spring or early summer if populations become high and leaf bronzing appears. See comments on Opal for aphids, above. Mites are usually controlled by natural predators.
San Jose scale	• Movento 240 SC	585 mL/ha	Monitor main branches for adult scale. This pest is rarely a problem on hazelnuts. **Movento:** Must be tank-mixed with a spray adjuvant/additive having spreading and penetrating properties at a suggested rate of 0.2 % v/v (2 L/1,000 L). See label for further details.
Spring-feeding caterpillars	Spring-feeding caterpillars are a complex of several species of Lepidoptera (moth family), including fruitworms, tent caterpillars, leafrollers, gypsy moth and others that are active early in the season from bud break through mid June. They cause varying degrees of damage in orchards. With the exception of leafrollers, there are no products registered for control of spring-feeding caterpillars. Many predatory and parasitic insects and diseases attack these pests and help to reduce caterpillar populations.		
Summer			
Aphids	Apply an insecticide listed for this insect under **Early Spring.** Some products have limited numbers of applications per year.		
Mites	• Acramite 50 WS	568 g/ha	Apply as soon as scouting indicates mites are present on foliage. Complete coverage of all affected plant parts (upper and lower surfaces) is necessary for effective control. Rate is sufficient to control two-spotted spider mite, the most common species present on tree nuts. If European red mite is present, apply higher labelled rate (851 g/ha).
Japanese beetle	Adult beetles can severely defoliate hazelnut orchards beginning in late spring and can continue well into summer. There are currently no insecticides registered for control of adult Japanese beetles on hazelnut. Clean cultivation may help reduce larvae populations in the orchard soil, however new adults usually fly in from other areas.		
Filbert worm	Filbert worm is native to Ontario on wild hazelnuts and may become a problem in commercial orchards. Monitor samples of nuts near harvest for signs of internal feeding by larvae. There are no insecticides registered for filbert worm on hazelnut.		
Wood-boring insects	Monitor main branches and trunk for small holes and sawdust on the ground near the trunk. Hazelnuts are host to several wood-boring insect pests that are common to commercial fruit orchards and forest tree and shrub species. There are no insecticides registered for wood-boring insects on hazelnut.		
Postharvest			
Bacterial blight	• Guardsman Copper Oxychloride 50 or Copper Spray	3 kg/ha 3 kg/ha	Apply the first spray in late August or early September before the start of the fall rains and nut drop. Repeat after harvest at leaf fall. Repeat in early spring just before leaf bud break. Use 3 kg/ha on small trees, and up to 9 kg/ha on large trees in proportionately more water.

Table 8-1. Products Used on Tree Nuts

Use this table as a guide but refer to product label for specific information.

The **preharvest interval** is the number of days between the last spray and first harvest.

The **re-entry period** is the minimum interval that must be observed between application of the pesticide and work in the treated crop without protective equipment. If no re-entry period is stated on the label, assume it is 12 hours.

The **maximum number of applications** is the labelled maximum number for the growing season and may be higher than what is recommended for resistance management or for the preservation of beneficial insects.

Product name	Registration number	Common name	Group	Preharvest interval	Minimum re-entry	Maximum number of applications per season
Products for insect control or suppression						
Acramite 50 WS[1,2,3]	27925	bifenazate	25	14 days	12 hours	1
Altacor[1,2,3]	28981	chlorantraniliprole	28	10 days	12 hours	3
Cygon 480-AG[2]	25651	dimethoate	1B	45 days		1
Dipel 2X DF[1,2,3]	26508	*Bacillus thuringiensis*	11	0 days		
GF-120[1]	28336	spinosad	5	0 days	When dry	10
Lagon 480 E[2]	9382	dimethoate	1B	45 days		1
Movento 240 SC[1,2,3]	28593	spirotetramat	23	7 days	12 hours	Use no more than 1.58 L/ha
Opal Insecticidal Soap[1,2,3]	28146	potassium salts of fatty acids	NC	0 days		
Surround WP[1,2,3]	27469	kaolin	NC	1 day		
Products for disease control or suppression						
Copper Spray[1,2]	19146	copper from copper oxychloride	M	40 days[1] 1 day[2]	48 hours	4[1], 3[2]
Flint 50 WG[2]	27529	trifloxystrobin	11	60 days	12 hours	4
Guardsman Copper Oxychloride 50[2]	13245	copper from copper oxychloride	M	1 day	48 hours	3

[1] Walnut.

[2] Filbert/hazelnut.

[3] Pecan and sweet chestnut.

NC = Not classified into family groups.

A blank cell indicates the information is not specified on the product label.

9. Other Pests and Disorders

Nematodes

Plant parasitic nematodes can cause significant yield losses to many horticultural crops. The extent of loss depends on the crop, nematode species and soil populations.

The most destructive and common nematodes in Ontario fruit crops are root-lesion *(Pratylenchus penetrans)* and northern root-knot *(Meloidogyne hapla)*. The northern root-knot nematode is becoming more prevalent. The pin *(Paratylenchus* sp.*)* and dagger *(Xiphinema* sp.*)* nematodes occasionally cause yield losses to some fruit crops in isolated fields. The dagger nematode is mainly a virus vector on grape, raspberry and apple.

Symptoms of nematode injury include:

- uneven plant growth
- poor plant establishment
- weakened plants over time
- poor root growth
- knots or galls on roots
- excessive branching of roots, hairy root symptoms

On strawberries:

- Root-lesion nematodes cause discolouration of the fine feeder roots and tiny, brown, scratch-like lesions on the young white roots. These lesions merge to form large brown areas. Root-lesion nematodes are involved in black root rot and aggravate verticillium wilt of strawberries and other host plants. Severely infected plants appear stunted and unthrifty.

- Root-knot nematode feeding stimulates root cells to enlarge. Enlarged cells look like small galls or beads (1 mm). As more and more nematodes establish feeding sites, they join together to become one larger root-knot.

On raspberries:

- Root-lesion nematode feeding causes scratch-like lesions on roots, similar to the symptoms on strawberry roots. Severely infested plants have thinner and fewer canes per crown. Up to 25% of first year canes may be killed by severe infestations of these nematodes.

- Dagger nematodes spread tomato ringspot virus, which causes crumbly berries, mottled leaves and cane dieback.

On tree fruits:

- Root-lesion nematodes can be a major cause of orchard replant failures. They can cause a decline in vigour of existing peach and cherry orchards. These nematodes cause small brown lesions on the white lateral roots and kill the fine feeder roots. When lesions merge, the entire root system appears discoloured. Root lesions are frequently invaded by other pathogens which can cause root rot. Severely affected trees may lose all feeder roots; young replant trees may die. Existing trees lack uniformity.

Thresholds

Nematode populations above economic thresholds can significantly reduce yields. The economic threshold for nematode populations refers to the population at planting. Planting a susceptible crop in soils with a population of nematodes near or above the population threshold will result in crop losses over time. For economic thresholds see Table 9-1. *Thresholds for Nematodes on Fruit Crops.*

Table 9-1. Thresholds for Nematodes on Fruit Crops

Type of nematode	Control when levels reach
Root-lesion nematode	1,000/kg soil (exception: 500/kg soil on strawberries)
Root-knot	1,000/kg soil
Pin	5,000/kg soil
Dagger	100/kg soil
Bulb and stem	100/kg soil

- Nematode problems are most often found in sandy-loam and sandy soils. Always sample these soils for nematode populations before planting fruit crops.

- Root-lesion and root-knot nematode problems are not usually found in clay or clay-loam soils. Sample these soils for nematodes before planting in replant sites or where susceptible crops have been recently grown.

- Also sample clay or clay-loam soils for dagger nematode on virus-susceptible grape, raspberry or tree fruit and for pin nematode on rhubarb, rose and gladiolus.

For more information, see OMAFRA Factsheet, *Sampling Soil and Roots for Plant Parasitic Nematodes,* Order No. 06-099. Information on how to sample soil for nematodes and where to send the samples is found in Appendix D. *Diagnostic Services,* page 290.

Nematode management

Use a combination of the following methods to manage nematodes:

- plant nematode-free transplants and seedlings
- rotate susceptible crops with non-host crops for several years
- plant nematode-suppressing cover crops
- destroy residual crop roots
- plant resistant fruit cultivars where available
- control weeds
- use soil fumigation when necessary

Cover crops for nematode suppression

Examples of nematode-suppressing cover crops:

- oilseed radish
- certain oriental mustard cultivars like Forage or Cutlass
- specific sorghum × sudan-grass hybrids
- African marigold cultivars like Crackerjack or Creole
- Canadian Forage Pearl Millet 101

These cover crops can reduce plant parasitic nematode populations. Not all cultivars reduce nematode populations, so choose the right variety. One or more years of nematode-suppressing cover crops may be required to reduce nematodes below economic thresholds.

Cover crops suppress nematodes in different ways:

- Canadian Forage Pearl Millet 101 is a poor host and inhibits the ability of root lesion nematodes to reproduce in its root-system.

- Certain cultivars of African marigolds produce a root exudate that kills nematodes in the soil.

- Nematode-suppressing cultivars of oilseed radish and certain oriental mustards produce isothiocyanate in their leaves, stems and petioles. This chemical is toxic to nematodes when the cover crop is cut green and incorporated immediately into the soil.

Exclude cover crops such as clovers and buckwheat from berry and orchard rotations. These are excellent hosts for root-lesion nematodes. Wheat or barley are the best cereal crops to grow before planting. For more information, see Table 3-18. *Characteristics of Cover Crops,* page 31.

Other cultural practices to reduce nematodes

Nematode populations can build on many weed species. A good weed control program is essential the year before planting fruit crops. Be sure to control weeds where nematode-suppressing cover crops are grown.

Keep land fallow the year before planting to reduce nematode numbers. A disadvantage to fallow land is increased susceptibility to soil erosion.

In orchards, choose ground covers between the rows that do not support nematodes, such as annual or perennial ryegrass.

Soil fumigation

Pre-plant soil fumigation is the most effective method of controlling nematode problems. Fumigants can be broadcast over the whole field or applied only in bands where trees will be planted. Tree-row application, or the treatment of a 2–2.5 m strip centered on the row, is more economical. However, broadcast fumigation will reduce the risk of re-contamination if non-fumigated soil is mixed into the fumigated strip.

For products, rates and other information on fumigants refer to Table 9-2. *Control of Nematodes and Other Soil-borne Pests before Planting Fruit Crops,* page 225.

Application of fumigants before planting

Most fumigants are applied by shank injection using specialized application equipment. Some formulations of Vapam and Busan can be applied to the soil surface and watered in. See the product label for application instructions.

- Fumigate when soil temperatures are above 4°C. Warmer temperatures (15°C and over) are preferred for more rapid fumigant dispersal in the soil. Fumigation the fall before planting is best for fruit crops, which are planted in early spring when soils are still cool.

- Land preparation is critical for effective fumigant application. Remove trash and old root systems. One week prior to fumigation, work the soil to a depth of 25–30 cm and obtain good seedbed tilth and moisture. Keep soil moist and if necessary irrigate the treated area during the week prior to fumigation.

Table 9-2. Control of Nematodes and Other Soil-borne Pests Before Planting Fruit Crops

CAUTION: These products are very toxic. Read the label and follow instructions for handling and application. Always follow manufacturer's directions carefully for dosage and methods of use. The applicator must wear suitable protective clothing, etc. These requirements vary between products and can be found on the label.

Product	% active	Ontario classification number[1]	Pests controlled (see label for exact registrations)			Fruit crop registrations	Rates for shank injection or broadcast application	Rates for sprinkler application
			Nematodes	Soil-borne diseases	Weeds			
Busan 1020	metam sodium 33%	Class 4	yes	yes	yes	fruit crops	375–935 L/ha (shank injection)	700–935 L/ha
Busan 1180	metam potassium 54%	Class 3	yes	yes	yes	fruit crops	231–576 L/ha (shank injection)	431–576 L/ha
Busan 1236	metam sodium 42%	Class 4	yes	yes	yes	fruit crops	274–683 L/ha (shank injection)	511–683 L/ha
Chloropicrin 100	chloropicrin 99%	Class 2	yes	yes	no	strawberries, raspberries	93 L/ha* (shank injection)	Do not apply with sprinklers
Enfuse M 510	metam sodium 42%	Class 4	yes	yes	yes	fruit crops	260 L/ha (broadcast)	Do not apply with sprinklers
Pic Plus	chloropicrin 85.1%	Class 2	yes**	yes	no	strawberries, raspberries	108 L/ha*** (shank injection)	Do not apply with sprinklers
Vapam HL	metam sodium 42%	Class 4	yes	yes	yes	fruit crops	279–696 L/ha (shank injection)	350–670 L/ha

[1] See *Pesticide Classification in Ontario*, page 285 for explanation of Ontario pesticide classifications.

* Use 140 L/ha Chloropicrin 100 for strawberry plant production (runner production).

** Pic Plus is labelled for root knot nematode but is not labelled for root lesion nematode.

*** Use 162 L/ha PicPlus for strawberry plant production (runner production).

- Seal the soil surface by packing or watering immediately after injection of the fumigant. For best results, keep the soil surface moist during application and for 24 hours after application.

- Leave soil undisturbed for at least one week after injection of the fumigant. Colder soils (below 15°C) require longer periods from injection to aeration.

- Work the soil and aerate for about a week before planting. For fall planting, work the soil and aerate for two weeks before planting. The time interval between fumigation and planting into fumigated soil depends upon the product used, the rate and the temperature following fumigation (consult product label).

- Use high-quality planting stock, preferably grown in fumigated soil.

- Always read the product label.

Fumigating single tree sites before planting replacement trees

When trees are replanted within an existing orchard, nematodes and diseases can be controlled in the planting hole using Vapam or Busan before planting. Refer to the product label for application details, rates and safety precautions.

Nematode suppression after planting

Vydate L will suppress nematodes after planting non-bearing apples (trees that will not bear fruit for 12 months) and raspberries. Vydate L is less effective than pre-plant soil fumigation and does not control soil-borne disease. Refer to the product label for application methods, mixing instructions, rates and precautions.

Apples

- **Soil drench and foliar spray:** Treat young whips and non-bearing fruit trees with one application of Vydate L as a soil drench around the base of each tree when roots are actively growing and leaf growth begins in the spring. Follow this with a foliar application of Vydate L; or,

- **Foliar application:** Make three foliar applications on a two to three week schedule for a total of three applications. Do not allow spray to drift onto trees in bloom. Do not apply to trees under water stress or not actively growing.

Raspberries

- Treat raspberry plants with one application of Vydate L as a soil drench over roots in the fall before October 31. Do not apply Vydate L to raspberries in the spring. Do not apply to raspberries more than once a year.

Vydate L is highly toxic to bees. Do not apply during the pink or bloom period.

Vydate L is very toxic to humans. Follow application instructions closely.

Do not re-enter treated fields for 48 hours after application.

Deer Control

Deer removal permit program

A permit is required to shoot deer in defense of property. Contact the local Ministry of Natural Resources (MNR) office for an evaluation and action plan. Action depends on the severity of damage, the level of previous control attempts and a reasonable expectation of problem deer control. The MNR area supervisor or enforcement supervisor issues permits to farmers or their agents. Take these steps to request a permit:

- File a written report, reflecting the extent of damage in percentage of crop loss and associated dollar value. The evaluator must consider the damage to be economically significant.
- Demonstrate that you have made reasonable attempts to control deer by modified farm management practices. Show that you permit licensed deer hunters on the property during open season, if any. Document this information and keep it with the deer removal permit file.
- Ensure appropriate arrangements for the disposal of the carcass(es) .

For more information, see OMAFRA Factsheet, *Rodent and Deer Control in Orchards,* Order No. 98-023.

Mouse and Vole Control in Orchards

Use a wide weed-free strip in the tree row or under individual trees, coupled with regular close mowing of orchard ground cover to help discourage mice.

- Remove straw, trash, sod, etc. from around the base of the tree for at least 60 cm from the trunk.
- Encourage predation by cats, foxes and birds of prey, especially red-tailed hawks, kestrels and great horned owls, which all help to reduce mouse populations.

Use a guard around the trunk of all newly planted trees. A number of commercial tree guards are available. Two of the most common are spiral plastic and galvanized wire mesh. Bury the bottom of the guard in the soil 5 cm deep, or preferably, in a mound of fine crushed stone or sharp cinders. Tree guards require regular maintenance.

- Check tree guards each fall to ensure they are mouse-proof and free of trash.
- Ensure tree guards do not interfere with root development as the tree grows.
- Spiral guards left in place too long can interfere with bark development. Remove guards before this occurs.

Bait for mouse and vole control in orchards

Broadcast bait over the floor of the orchard before the grass falls over and the ground is covered with snow. Apply bait on bright days with no rain expected for several days. If further mouse activity is detected, repeat the treatment when rain is not expected. In addition to using baits, pick up and remove dropped fruit from the orchard.

Several commercial formulations of bait are available for orchard use (see Table 9-3. *Bait for Mouse and Vole Control,* page 227). Consult the label before application and obey all safety instructions.

- Baits are poisonous to humans, domestic animals and wildlife.
- Store the bait away from children, irresponsible persons and animals.
- Wear chemical-resistant gloves and wash hands after handling poison baits.
- Avoid inhalation of dust or fumes.

Table 9-3. Bait for Mouse and Vole Control

Product name	Active ingredient	Application rates	Crop registrations	Comments
Ramik Brown	diphacinone	• No application rates on the label.	orchards, Christmas tree plantations, newly reforested areas, shelter belts and nurseries	Bait MUST be placed in either tamper-resistant bait stations or in locations not accessible to children, pets or livestock. DO NOT place bait in areas where there is a possibility of contaminating food or surfaces that come in direct contact with food.
Bartlett Waxed Mouse Bait	zinc phosphide	• 4.5–9 kg/ha, depending on severity of infestation. • Or place in bait stations, 15 g of bait per bait station.	orchards, Christmas tree plantations, newly reforested areas, etc.	Apply in early fall, or any time before a covering of snow. Distribute evenly but do not apply to bare ground.
Rodent Bait or Rodent Pellets	zinc phosphide	• 4.5–9 kg/ha, depending on severity of infestation. • Or place in bait stations.	orchards, nurseries, fruit and vegetable storage areas (in bait stations)	Best timing is after apple harvest before leaf-fall or lodging of the grass. Repeat at least once before snow is expected.

- Destroy empty containers safely.
- Keep children, pets and domestic animals away from treated areas.
- Where possible, remove mouse bodies and bury or dispose of them in a safe manner.

Bait stations help control mice longer than broadcast treatment. Bait stations also help prevent non-target mammals from feeding on the bait. Set up bait stations at a rate of approximately 25/ha.

- Place bait in tamper-resistant bait stations or in locations not accessible to children, pets or livestock.

To ensure safe use of this product, tamper-resistant bait stations must have the following characteristics:

- Constructed of high-strength materials and resistant to destruction by children and non target animals.
- Entrance designed to ensure children and non-target animals cannot reach the bait.
- Internal structure that prevents bait from being shaken loose.
- Access panel that fastens securely and locks (e.g. metal screw or padlock).
- Capable of being securely fastened to a surface (e.g. nailed down).
- Clearly labelled: WARNING – POISON.

For more information, see OMAFRA Factsheet, *Rodent and Deer Control in Orchards,* Order No. 98-023.

Controlling Rabbits

Wrapping young trees

To protect young trees from rabbits, wrap burlap around the top and the trunk of the tree (above the mouse guard). Tie the wrapped tree securely to a strong stake or steel fence post to prevent snow and ice breaking the tree over. Mouse guards generally do not give protection against rabbits when the snow is deep.

Repellents

Rabbits do not like to feed on the trunks of young trees if the trees have been treated with thiram. Products such as Skoot, and other commercial mixtures containing thiram, can be painted directly onto the tree trunks by hand or diluted with water for backpack sprayer application. Be sure to treat the tree as high as rabbits can reach when they stand on deep snow.

For more information about the application of paint with thiram, refer to *Control of Southwest Injury on Fruit Trees,* page 229.

Repairing damage by mice and rabbits

Carry out regular inspection throughout the winter to check for injury. Mice often feed just below the surface of the snow or in the litter. If a tree has been wholly or partially girdled, cover the wound with grafting compound or wound dressing promptly or before it dries out.

The process for repairing fruit trees damaged by mice and rabbits is described in OMAFRA Factsheet, *Repair Grafting,* Order No. 98-003. Before the buds swell in the early spring, secure scions that are long enough to bridge the wound. Store scions in damp sand or sawdust in a cool place, preferably in refrigerated conditions. Avoid storing scions with apple fruit to avoid ethylene damage. If the wound extends for more than one quarter of the circumference of the trunk, use scions to connect the healthy tissue by bridge grafting. Graft when the bark slips readily from the wood, usually about bloom. This technique is not practical on trees with a diameter less than 10 cm. Instead, replace small trees.

For more information, see OMAFRA Factsheet, *Rodent and Deer Control in Orchards,* Order No. 98-023.

Bird Control

Every year birds destroy large quantities of fruit in Ontario. Sweet cherries, grapes, blueberries and Saskatoon berries are the crops most subject to attack, but other fruit crops may also be damaged. The amount of loss due to birds depends on the cultivar, the time of season, location in the province, proximity to bush and hydro lines, and availability of other food sources. Losses range from relatively minor to total crop loss. Actual losses are difficult to measure, since fruit that has disappeared is hard to account for. Pecking and puncturing damage are often as great as actual losses from fruit consumed and can cause secondary problems with rot.

Controlling bird damage

Fruit becomes attractive to birds as it begins to colour. Birds are very selective and quickly learn where to find the most tasty, ripe fruit. Start controls early, 10–30 days prior to colouring of the fruit, depending upon the cultivar. An integrated approach using several control methods is necessary for effective and long lasting control.

Location: Where you plant commercial fruit crops can be an important factor in bird control. Fruit crops planted near wooded areas or hydro lines are particularly susceptible to damage, because birds nearby find shelter, perching locations and nest sites.

Physical protection: The only completely effective control method is to cover the crops with netting. This method may be economically feasible for some higher valued cultivars of grapes, cherries and highbush blueberries. However, nets are not the answer in every situation since they can be costly to purchase and install, as well as difficult to work with. There is considerable interest by growers to find simpler, cost-effective netting systems for fruit crops.

Shooting: Normally, shooting does not significantly reduce bird populations, but it does frighten them out of the orchard. Laws protect robins and northern orioles, but special permits may be obtained to kill them if you can show they are causing damage.

For a permit, contact the permit office, Canadian Wildlife Service, Environment Canada, at 905-336-4464.

Pyrotechnic pistol cartridges are also available with delayed explosions and/or sustained whistles that disorient and frighten birds.

Propane-fired bird scaring cannons: Cannons are one of the most commonly used bird scaring devices. Loud, unexpected gunshot-like sounds, produced at random intervals, cause birds to flee. Move the cannons periodically to different locations in the orchard or vineyard. Birds quickly adjust their feeding habits if cannons are in the same location throughout the harvest season.

A major drawback of these devices is the disruption to neighbours. Growers must recognize this and adjust usage to minimize discomfort to neighbours. Most neighbours are sympathetic to the need for crop protection, but may complain if the equipment is not used properly.

- Fire cannons only during bird forage periods in daylight hours, generally accepted as 30 minutes before sunrise and 30 minutes after sunset. Check the local newspaper or radio for sunrise and sunset times in your area. Operation outside these times is not considered a normal farm practice.
- Place cannons as far away from neighbours as possible and at least 125 m (410 feet) away from their houses.
- Operate cannons on the Frequency 2 setting, meaning the firing sequence occurs randomly during a four to eight minute span.
- Do not place cannons closer than 75 m apart.
- Make sure cannons are level so they fire in all directions uniformly.
- Monitor the equipment regularly to ensure it functions properly, especially if the equipment is leased.

Electronic sound devices: This equipment emits electronic or other types of sounds that imitate distress or predator calls of different bird species. The sound produced, although loud, is usually less objectionable to neighbours than propane-fired cannons.

- Operate electronic sound devices only during daylight hours.
- Move the equipment periodically for maximum effectiveness.

Chemical controls: Currently, there are no chemicals registered for use in Ontario to control birds in fruit crops. It is illegal to use unregistered chemicals.

Visual deterrents: Visual deterrents include: aluminum foil hung in trees, model hawks and other birds of prey, strips of yellow plastic hung across vineyards, vibrating plastic strips, scarecrows, mirrors, kites and scare-eye balloons. Most visual deterrents move with the wind, produce noise and make reflections. Other visual deterrents on trial in Ontario include the use of lasers to disperse birds and robotic scaring devices activated by bird movement.

Falconry: Trained falcons and hawks provide successful bird control. Experienced falconers are needed to fly the birds. Availability, cost and time are major drawbacks of this approach for fruit growers.

Regardless of the bird control method used, follow all local, provincial and federal laws. For more information on bird control, see OMAFRA Factsheets, *Using Propane-Fired Cannons to Keep Birds Away from Vineyards,* Order No. 09-001 and *Bird Control on Grape and Tender Fruit Farms,* Order No. 98-035.

Control of Southwest Injury on Fruit Trees

Southwest injury, or winter sunscald, occurs in the winter and is especially severe when cold, still nights follow cold sunny days. This phenomenon can occur in apple, peach, pear, cherry, plum, apricot and tree nut orchards. The damage is usually confined to the south and southwest sides of the trunks and main scaffold branches. On sunny days these tissues become considerably warmer than the surrounding air and at night they cool rapidly. Under these conditions, freezing of the bark and underlying tissues may occur. This injury usually affects large portions of the bark tissue that become brown and eventually slough off as healing occurs beneath.

In stone fruit orchards, these injuries provide ideal sites for infection by peach canker or other canker diseases. The combined effect of southwest injury and peach canker greatly reduces the productive life of affected trees. Recent increases in apple tree cankers may also be linked to problems with southwest injury in the winter.

Paint the trunk, crotches and lower parts of main scaffold branches thoroughly with exterior white latex paint to minimize southwest injury. The white paint reduces the damage by reflecting direct sunlight from the exposed tissue. This helps to reduce rapid warming on sunny days when air temperatures are below freezing.

Avoid oil-based or latex paints that contain any oil. These products contain toxic materials that may injure or kill fruit trees.

- October is the best time to apply the paint. For best results, paint trees on days when the temperature is above 10° C and when the paint or spray will dry rapidly.
- Apply the paint by brush or spray. If you choose spray, dilute the paint with 1–2 L of water/4.5 L of paint, depending on the thickness of the paint and the air pressure available.
- On young trees, paint the whole trunk. Only the south and southwest sides of older trees require paint. The whiter the bark after you paint, the greater the protection. Better quality paints are more durable.
- On young trees, injury from rodents may be a greater problem than southwest injury. To obtain protection from both problems, use commercially available thiram-latex mixtures, which reflect sunlight and repel rodents (e.g. Skoot). Avoid contact with eyes, skin and clothing with products containing thiram.
- Do not use the thiram-latex mixture if you plan to use a fall Bordeaux spray program. The thiram reacts with the Bordeaux spray, changing the colour of the paint from white to brown and reducing its effectiveness as a heat reflector. The Bordeaux spray does not affect trees painted with latex only and can be used when thiram is excluded from the mixture.

Preventing Heat Stress and Fruit Sunburn on Apple and Pear Trees

Surround WP Crop Protectant is highly refined kaolin clay. Applied to the tree canopy, it forms a microscopic particle film that protects both leaves and fruit from high UV light and heat, which can slow the photosynthetic rate in a tree canopy.

The benefits of using Surround WP on young apple and pear trees during their establishment include:

- greater net accumulation of carbon from photosynthesis
- enhanced fruit bud initiation
- increased trunk diameter
- increased shoot growth

In established orchards, trees treated with Surround have healthier foliage through to leaf drop. Plant dormancy is not affected. Fruit finish and marketable yield are improved on several cultivars.

To prevent heat stress, make two applications of Surround WP, 7 days apart, using 50 kg/ha. Begin spraying before heat stress is likely to occur. Continue applications at 7–14 day intervals at a reduced rate of 25 kg/ha to maintain even coverage.

Precautions when using Surround:

- Do not mix Surround with spreaders, stickers or anti-foaming agents.
- Do not spray when bees are active.
- In orchards treated with Surround, monitor fruit maturity carefully and use starch iodine tests in the last two weeks of crop development.

For information on using Surround to suppress crop pests, see notes on *Biopesticides for Insect Control; Kaolin Clay (Surround WP)*, page 247.

10. Pesticide Application

Handling and Mixing Pesticides

Formulations

Dry pesticide formulations include wettable powders, granules, and soluble powders.

Wettable powders are active ingredient added to a wetting and dispersion agent, such as talc mixed with water, they will not dissolve, but form a suspension that requires constant agitation. Unless the label claims otherwise, premix wettable powders with water and add the slurry to the spray tank.

- Granules are a mix of dry, large free-flowing particles usually with a low concentration of active ingredient. They are ready to be added directly to water.

- Soluble powders are dry materials, similar to the granules, but they do dissolve in water.

Liquid pesticide formulations mix in water to form a solution. Some pesticides may be oil-based, such as emulsifiable concentrates, and form an opaque (milky) emulsion that requires agitation.

Soluble packaging

Choose soluble packages that dissolve in the carrier water to reduce container disposal issues. Water-soluble packaging is used for dry flowable and wettable powder formulations of pesticides and is available under names such as Clean Pak, Solupak, and Toss-N-Go. In most cases, the water-soluble packaging material is PVA (poly vinyl alcohol). This material dissolves completely when added to the water in the sprayer tank according to instructions.

- Read all labels and instructions carefully. For more details contact the vendor.

- Keep soluble pouches dry until added to the spray tank.

- Do not handle pouches with wet hands or wet gloves.

- Do not remove pouches from the outer package until just before use.

- Always reseal the outer package to protect the remaining pouches from moisture.

Mixing soluble pouches

Consult product labels for specific mixing instructions for each product.

1. Half-fill the spray tank with water and have the agitator running – then add the water-soluble pouches to the tank.

2. Most pouches dissolve completely within 5 minutes, depending on the water temperature and the degree of agitation.

3. As the tank continues to fill, add any other compatible pesticides.

Do not add:

- A pesticide that is incompatible with the PVA packaging material. The PVA material is not soluble with oils (e.g. Superior Oil).

- Any material containing boron (e.g. Solubor), chelated micronutrients or water-soluble fertilizers. This combination is likely to cause a sticky, insoluble substance in the tank.

Compatibility of spray materials

Users of commercial class pest control products used for crop protection or vegetation management are permitted to apply unlabelled tank mixes of registered pest control products as long as:

- each product is registered for use in Canada on the crop,

- the tank mix only includes an adjuvant when specifically required by one of the product labels,

- the application timing of each product is compatible with crop and pest staging,

- each product is used according to the label,

- no product is specifically excluded on any other of the tank-mix product labels.

For information on compatibility of spray materials, always check the product label. Compatibility refers to the physical or chemical compatibility of two products in a solution.

Physical incompatibility can result in a physical change in the solution. Components of the combined product may plug nozzles or become solidified or gummy in the tank.

Chemical incompatibility can result in a chemical change in the solution. This can lead to reduced efficacy, or can cause plant injury when sprayed on the crop. The results of a chemical incompatibility may not be evident until after the spray is applied.

In general:

- Compatibility of two products varies with the formulation of those products. For example, two products may be compatible as wettable powder formulations, but the same active ingredient may be incompatible as emulsifiable concentrate formulations.
- Compatibility generally refers to two-way mixtures. Adding a third product to a tank-mix, even if all are compatible with each other in two-way combinations, may result in incompatibility.
- Compatibility of some materials may depend on the solvents and emulsifiers the manufacturer uses. Emulsifiable concentrates are more likely to cause compatibility problems than wettable powders. If wettable powders are mixed with emulsifiable concentrates, incompatibilities may result.

Specifically:

- When mixing Captan or Maestro with emulsifiable concentrate formulations of pyrethroids, add Captan or Maestro first. Apply immediately with constant agitation.
- Do not mix pesticides with lime sulphur or streptomycin.
- Do not use oil sprays within 14 days of Captan or Maestro. This applies also to the oil used with Agri-Mek.
- Water soluble, polyvinyl alcohol packaging material is not compatible with Superior Oil, or emulsifiable concentrate formulations containing mineral or vegetable oil products.
- Water-soluble packaging is not compatible with boron, some chelated micronutrients and water-soluble fertilizers. Rinse the spray tank carefully after applying these nutrients, before using products in water-soluble packages.

For more information on compatibility, contact the product manufacturer or dealer.

Jar test for testing compatibility of pesticide mixtures

Always wear personal protective equipment (PPE) when performing a jar test for compatibility. Conduct the test in a safe and ventilated area, away from sources of ignition.

1. Measure 500 ml of water into a one litre glass jar. This should be the same water you would use in the spray tank.
2. Add ingredients in the following order, stirring after each addition:
   a. Compatibility agents and activators. Add 5 mL for each 500 mL of product labelled for 1,000 L of final spray.
   b. Wettable powders and dry flowables: Add 15 grams for each 500 g of product labelled for 1,000 L of final spray.
   c. Water soluble concentrates or solutions: Add 5 mL for each 500 mL of product labelled for 1,000 L of final spray.
   d. Emulsifiable concentrates: Add 5 mL for each 500 mL of product labelled for 1,000 L of final spray.
   e. Soluble powders: Add 5 mL for each 500 mL of product labelled for 1,000 L of final spray.
   f. Remaining adjuvants and surfactants: Add 5 mL for each 500 mL of product labelled for 1,000 L of final spray.
   g. Let solution stand in a ventilated area for 15 minutes and observe results. If mixture is giving off heat, these ingredients are not compatible. If scum forms or solids settle to the bottom (except for the wettable powders) the mixture is likely not compatible.
3. If no signs of incompatibility appear, test the mixture using a spray bottle on a small area where it is to be applied. Look for phytotoxic indications such as plant damage and monitor efficacy.

Filling and Agitation

Tank water

- Mix pesticides with clean water that does not contain debris, sand, mud or organic matter.

- Never let the water intake screen rest on a pond bottom when filling a sprayer.

- The water intake line near the screen must, by law, have a check valve or anti-backflow device. This prevents water-source contamination when the pump is shut off.

- Do not use a tank-refilling nozzle, volume-booster nozzle, or injection pump when refilling sprayer tanks from ponds or streams. These tank-refilling aids may contaminate the water source.

- When using a farm water supply, install a frost-free water hydrant outside the building. Place an anti-backflow valve or siphon prevention on the discharge end of the hydrant.

- If required, adjust the pH or hardness of the water before mixing spray materials in the tank. Where water is known to have an excessive salt content, compatibility of the water and the chemical at field strength should be tested first on a small scale.

Agitation

Agricultural products are formulated to be as emulsifiable as possible, but many do not mix well in water. They contain elements that do not dissolve (e.g. wettable powders), or they may be petroleum distillates (e.g. emulsifiable concentrates). Other products are heavier than water and form precipitates (e.g. fertilizers and powdered metals). Consequently, good agitation is very important.

Effective agitation requires water to "sweep" the bottom of the tank so that any precipitated material is picked up and re-mixed. Turbulence is not enough. If there is too little agitation, the pesticide will be applied unevenly. If there is too much agitation the pesticide may foam or cause an invert emulsion (forming a gel).

There are two common types of agitation: mechanical and hydraulic.

Mechanical agitation is produced by paddles that are attached to a shaft mounted near the bottom of the spray tank. While relatively effective, this system cannot always sweep the very bottom of the tank, so there is always some material that precipitates out of reach.

Hydraulic agitation is accomplished by returning a portion of the pump output to the tank. Cylindrical and oval tanks are the ideal configuration for the rinsing (i.e. sparging) type of hydraulic return agitation system. This system consists of a tube located longitudinally along the wall of the tank, with volume booster nozzles aimed at that centerline so they sweep across the bottom. Volume booster nozzles take a small amount of water pumped into their venturi chamber and create a vacuum that draws three to four times that volume from the surrounding water and expels it out the end. For hydraulic agitation to be effective, the agitator nozzle(s) should be fed by a dedicated line from the pressure side of the pump (not the pressure regulator). They should have a valve to throttle the flow or completely shut it off to prevent foaming.

Filling the tank

Pesticide labels usually provide directions for mixing different materials, including the sequence for mixing. Unless otherwise specified (such as when using soluble pouches), follow the W.A.L.E.S. method. In a half-full tank with agitator running, add:

1. **W**ettable powders and flowables (including dissolvable packages)

2. Fill tank to ¾ full, agitate and then add

3. **A**djuvants such as anti-foaming compounds, buffers

4. **L**iquid and soluble products

5. **E**mulsifiable concentrates

6. **S**urfactants

Finish filling the spray tank to the required volume. Maintain continuous agitation during mixing and final filling, and throughout application.

To prevent oil buildup in the sprayer, empty the tank completely before refilling.

Clean the tank and sprayer with a detergent or solvent immediately after use, then flush thoroughly with clean water.

Calculating Water Volume and Pesticide Rates

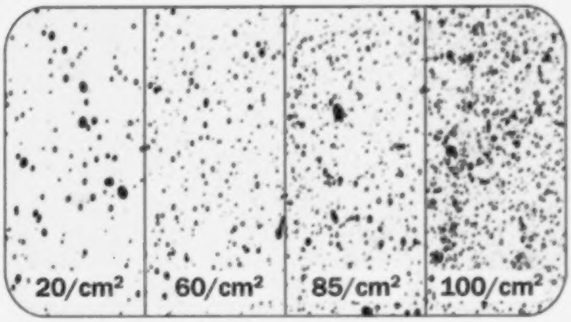
The pesticide label provides the safest and most effective application rate. For spraying, it is the dose rate multiplied by the carrier volume per area of crop. For example:

A		B		A × B
Carrier volume	×	Dose rate	=	Application rate
1,000 L/ha		50 g / 100 L		500 g/ha

The purpose of the carrier (typically water) is to convey the pesticide to the target and distribute it evenly. Generally, more discrete droplets per unit target area indicate more effective the application, but unless specified by the label, targets do not have to be drenched. With the exception of miticides and plant growth regulators, an evenly distributed droplet density of approximately 85 fine/medium droplets per square centimetre in the hardest-to-reach portion of the canopy signifies adequate coverage.

Figure 10-1. Water-sensitive Papers Showing a Range of Spray Coverage

These water-sensitive papers illustrate a range of coverage from 20–100 fine-to-medium droplets/cm². Ideal coverage is a minimum of 80–90 fine-to-medium droplets/cm² for most fungicide and insecticide applications.



Carrier volume

High volume airblast spraying is sometimes referred to as dilute spraying. Dilute sprays are applied in enough water volume to wet all foliage to the point of runoff. For example, chemical thinners and dormant oils are applied at high volumes to ensure contact with 80% of the flowers or to drench all surfaces, respectively. The volume of liquid that can be retained on a surface is limited, so once wetted, the surplus drips down to the lower leaves and onto the soil. Once runoff has begun, the amount of product deposited is proportional to concentration but independent of carrier volume, which means deposit can never exceed dose once runoff has begun. In fact, runoff has been shown to reduce coverage and concentrate products at the edges of leaves. Although growers rarely use dilute sprays, it is important to know the amount of water required to achieve a dilute rate without incurring runoff. Adjust spray volume to match the density and volume of the crop canopy by:

- shutting off nozzles
- changing nozzles to provide different rates along the spray boom (preferred method)
- adjusting travel speeds or spray pressure slightly (for minor changes only)

Using lower water volumes to apply pesticide takes less time and less water. However, excessively low-volume applications often result in poor control of scale insects, mites and woolly aphid, especially in tree tops. Further, inclement conditions such as low humidity, high temperature or high winds will increase the rate of spray evaporation and re-direct the spray, greatly reducing coverage in low volume applications.

Dose rate

Historically, dose rates for orchard spraying in Ontario were determined through efficacy trials where standard trees (4.5–5.5 m high) were sprayed to runoff with a handgun at 3,740 L/ha (400 US gallon/ac), and the effective rate was expressed per 378.5 L (100 US gallon). Label rates are still determined through trial and error, but are tested using today's denser, size-controlled plantings.

These modern pesticides often express dose rate as the lowest effective amount of product applied per hectare of crop. These area-based rates are ideal for boom or aerial spraying. However, orchards and vineyards are three-dimensional targets planted in rows and are typically sprayed from within the canopy. Depending on how efficacy was originally determined, it is possible to over-apply for small plants with large spacing in early season, or to under-apply for large plants in dense plantings late in the season.

Crop-Adapted Spraying (CAS) matches the carrier volume and/or dosage to the size, shape and density of the target crop.

Crop-adapted spraying and application rates

Many models have been developed to guide operators in their decision to modify application rates, each relying on certain assumptions with varying degrees of success. The Tree Row Volume (TRV) system translates ground-area rates to volumetric rates using a formula based on tree height, width, row length and distance between rows. It does not account for sprayer efficiency or the area-density of the canopy, which accounts for 80% of the deposit variability between canopies. Therefore, TRV is generally considered too complex and is only a partial solution.

For vineyards, the Australian Vine Row Volume (VRV) was replaced by the Unit Canopy Row (UCR) concept, which also adjusts the application rate requirements on the basis of crop row-length rather than ground-area. However, UCR does not consider the canopy type, area-density or sprayer efficiency.

Many of these models are complicated, and have proven inaccurate or inappropriate for Ontario growers. As a result, growers have adopted their own methods using a trial and error approach, which may or may not provide adequate coverage. Until a simple and consistently effective CAS system is developed, only mechanical changes to nozzle orientation, airflow and droplet size are recommended.

The pesticide label is a legal document. Dose rates cannot be exceeded, but unless specifically prohibited, lower rates and higher concentrations can be used in certain situations. Growers who reduce rates or use very low water volumes take the risk of reduced protection, increased potential for pest resistance and phytotoxicity. The registrant is not legally responsible for these risks unless you follow the label exactly.

Sprayer Calibration and Nozzle Maintenance

Calibration is a test measurement of the performance of the application equipment under typical operating conditions. This generally means nozzle orientation and output, which change over the spraying season. Calibration is recommended twice per season – at the beginning and about mid-way through. A properly calibrated sprayer can prevent many of the following problems:

- Pest Escapes: Uneven application or improper dosage can result in poor pest control.
- Pesticide Residues: Inconsistent application rates may leave excessive residue levels on fruit.
- Crop Damage: Uneven nozzle outputs can deposit too much product on sensitive crops.
- Poor Returns: Expensive re-application of pesticides together with losses in yield and quality can lower expected returns on high value crops.
- Drift: Improperly oriented nozzles and inaccurate gauges can contribute to drift.

Calculating travel speed

Speedometers can become inaccurate over time or because of wheel slippage during spraying. An important part of sprayer calibration is checking your travel speed by timing how long it takes to drive over a measured distance under true field conditions.

- Use a tape measure to place two stakes 50 m apart in the field.
- Fill the sprayer half full of water.
- Select the throttle and gear settings you plan to use when spraying.
- Drive the distance between the stakes three times, timing each pass in seconds. Each time, make sure the tractor is at the desired spraying speed as you pass the first stake. Keep driving at this speed until you pass the second stake. Run the course in both directions and do not drive in the same tracks.
- Take the average time of three passes and use the formula below:

A		B		C		(A÷B)×C
Test distance	÷	Average travel time in seconds	×	Constant	=	Driving speed in km/hr
50 metres		36.25 seconds		3.6		5.0 km/hr

A modern alternative is to use a hand-held GPS receiver to determine accurate travel speed in specific gears at known RPMs. This tool is also handy for measuring row length and block areas.

Nozzle maintenance

Nozzle wear or tip damage has a direct impact on product effectiveness and cost. The rate of tip wear depends on spray pressure, product sprayed, and the material of which the nozzle is made. Do not use nozzles made of different materials on the same boom. Upgrading to a harder, more durable tip can reduce maintenance costs, but even ceramic tips will not last forever. The most common tip materials, listed from softest to hardest, are:

- brass
- stainless steel
- plastics
- hardened stainless steel
- ceramic

Calculating Output

Timed output of the average nozzle

1. Park the sprayer with the power take-off (PTO) engaged and the throttle adjusted to reach the PTO speed (typically 540 RPMs) set in the test run.

2. Adjust the pressure regulator to the desired working pressure with full flow to the boom.

3. Collect the output from each nozzle (in milliliters) for the average length of time needed to travel the 50 m in the test run. For airblast sprayers, it is helpful to use a flexible tube such as a dairy inflation tube to guide the spray from the nozzle to the graduated cylinder.

4. Record the output volume for each nozzle, either by reading the graduations, or weighing the vessel on a kitchen scale. One millilitre of clean water weighs 1 gram. Be sure to subtract the weight of the vessel.

5. Add up all of the nozzle outputs and divide by the number of nozzles. This will give you the average output per nozzle.

6. If the flow rate of a single nozzle is 5% more or less than the average, replace all nozzles, not just those that appear damaged.

Do not over-tighten nozzles. For disc-core or disc-whirl nozzles that require gaskets or washers to maintain a tight seal with the cap and body, it is recommended to replace the disc, core and gasket or washer at the same time. Depending on the nozzle material, plan to replace nozzles once a year or at the first signs of deterioration. Brass, for example, typically does not last an entire season of spraying. The cost of renewing an entire set of nozzles is a fraction of the potential cost of wastage and potential crop damage. Inevitably, all nozzles will wear out.

Horizontal boom sprayer – total output

- Measure the spacing between nozzles in metres.

- Use the following formula to determine the sprayer output:

A		B		C		(A÷B)xC
Output of an average nozzle (for average amount of time needed to travel 50 m)	÷	Nozzle spacing (m)	x	Constant	=	Sprayer output (L/ha)
2,000 mL		0.5 m		0.2		200 L/ha

- Calculate the actual area sprayed after each tank of spray solution is applied. Re-check the actual sprayer calibration after each tank of spray is applied by dividing the volume sprayed by the actual area sprayed. The nature of some products may slightly alter the calibration from that of clean water.

Horizontal boom sprayer – band spraying output

For banded spray applications, measure the width of the spray band (at the soil surface or surface of the crop canopy) and enter this value into the formula instead of the "nozzle spacing".

For example, if the sprayer has 10 nozzles and each nozzle covers a 36 cm (0.36 m) band, the total width of the spray patterns (swath width) is: 10 × 0.36, or 3.6 m.

For band spraying, the area sprayed is not the same as the field area. Unless otherwise stated, herbicide rates in most publications and labels refer to the field area sprayed (i.e. if an insecticide was applied at 1 kg/ha in a 3 m band over rows spaced 10 m apart, the 1 kg would cover 3 hectares of crop).

Airblast sprayer output in an orchard or vineyard

Information you will need:

- Forward Speed – e.g. 5 kilometres per hour.

- Target Output – e.g. 2,000 litres per hectare (214 US gallons per acre).

- Row Spacing – e.g. 3 metres.

- Number of Active Nozzles – e.g. 12 per side for a total of 24 nozzles.

Calculate time to spray.

Distance to cover 1 hectare in metres.

A		B		A÷B
Area of a hectare	÷	Row spacing	=	Travel distance per hectare
10,000 metres²		3 metres		3,333.3 metres

Time to Spray 1 hectare (not including turning or refill time).

A		B		C		(A÷B)xC
Travel distance per hectare	÷	Speed in metres per hour	×	Minutes per hour	=	Time to spray in min. per hectare
3,333.3 metres		(5 km/hr × 1,000)		60		40 min.

Calculate sprayer output per minute.

Output per nozzle per hectare.

A		B		A÷B
Target output (litres per hectare)	÷	Total number of nozzles	=	Total nozzle output per hectare
2,000 L/ha		24		83.3 L/ha

Output per nozzle in litres per minute.

A		B		A÷B
Total nozzle output per hectare	÷	Time to spray in min. per hectare	=	Nozzle output In litres per minute
83.3 L/ha		40 min.		2.1 L/min.

From manufacturer's nozzle charts, find a nozzle that gives this output at the selected operating pressure. This gives an even distribution of spray rates for each nozzle, but does not reflect the shape of the target tree or vine. When added, the total output should be close to the value calculated. For small trees, block off enough of the top and bottom-most nozzles to prevent waste of spray.

Figure 10-2. *Distribution of Airblast Output for a Classic Spindle Apple Orchard,* and Figure 10-3. *Distribution of Airblast Output with Towers for a Classic Spindle Apple Orchard,* both on this page, show the distribution of output for a classic spindle apple orchard. Adjustments in output should reflect the density of the canopy the nozzles are aimed at – in other words, the more canopy, the more output required.

Figure 10-2. Distribution of Airblast Output for a Classic Spindle Apple Orchard

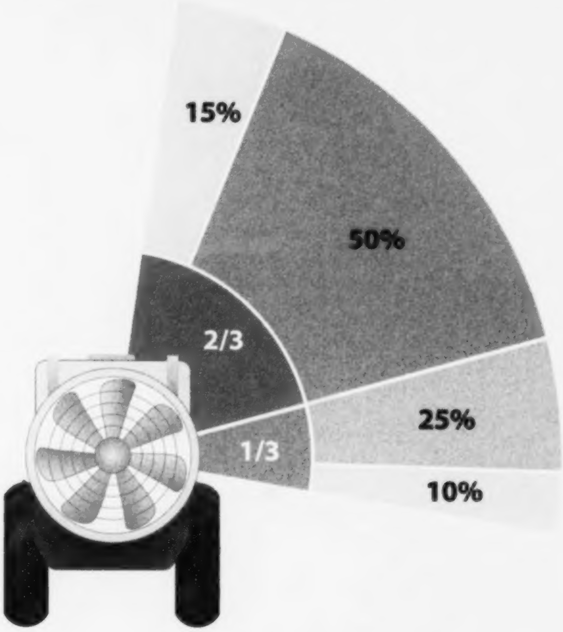
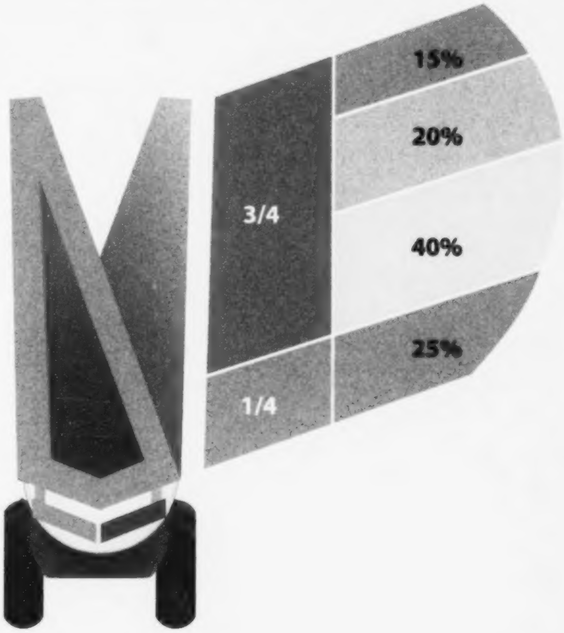


Figure 10-3. Distribution of Airblast Output with Towers for a Classic Spindle Apple Orchard



New Developments in Spraying Technology

Advances in modern spray technology reduce drift and off-target effects of pesticide application and improve efficiency. New concepts include:

- Closed injection-type systems that carry pesticide concentrate separately from the water carrier and mix it with water before it reaches the boom.
- Electronic rate controllers which use speed sensors and flow controllers to maintain the desired application rate.
- Variable rate and blended pulse width modulating nozzles that maintain or control spray quality independent of spray pressure.
- SONAR, LIDAR and LED sensor systems to detect weeds and gaps in target foliage and automatically adjust boom height.
- Global positioning systems (GPS) to accurately sense true ground speed, map applications, align spray swathes and map soil conditions.
- Crop-adapted spraying models that modify spray volumes and label rates based on planting density, plant size and stage of growth.

Single-piece moulded nozzle tips

- Moulded, single-piece nozzle tips are available in hollow and full cone patterns. Unlike disc-whirl nozzle tips, which have tight gaskets and O-rings, it only takes seconds to replace moulded tips.
- Moulded nozzle tips are brightly coloured and coded to indicate the flow rate. This makes it easy to confirm spray distribution at a glance. Moulded tips will not produce as much output as disc-core or disc-whirl tips, so they may not be suitable for spraying plant growth regulators or dormant oils that need lots of volume. On most sprayers, the maximum output is about 650 L/ha (~70 US g/ac) when single piece nozzles tips are used.
- Moulded single piece nozzle tips easily fit onto Turbomist® and Durand Wayland®-style nozzle bodies.
- For Greenlea's GB®, or FMC® and John Bean® sprayers, the nozzle body must be replaced to accept the tips. This is not a difficult job and provides an opportunity to install check valves as well. Check valves will prevent the tips from leaking as lines drain when the pump is off.

Air-induction nozzles on airblast sprayers

- Consider drift-reducing air induction nozzles, which create coarse (or very coarse) droplets rather than fine drift-prone droplets. Growers report less "mist" hanging in the crop while spraying with air induction nozzles. The sprayer does not create a large visible plume when spray is applied, which is good when there are onlookers.
- International research, and trials in Quebec and Ontario indicate that applications from air induction nozzles are as efficacious as disc-core or disc-whirl. However, in cases where trees are very large or dense (e.g. standard apple) or where pesticide labels specifically require a small droplet size, air induction nozzles may not be appropriate. This is because large droplets might lose momentum and fall out of the air rather than disperse evenly throughout large canopies.

Other Resources

- *Best Management Practices – Pesticide Storage, Handling and Application,* Order No. BMP13 and *Best Management Practices – Integrated Pest Management,* Order No. BMP09.
- Ontario Pesticide Education Program (University of Guelph, Ridgetown College) sprayer videos: *http://www.opep.ca/index.cfm/learning-resources/videos/.*
- OMAFRA Factsheet *How Weather Conditions Affect Spray Applications,* Order No. 09-037W (web only).
- OMAFRA Factsheet *Six Elements of Effective Spraying in Orchards and Vineyards,* Order No. 09-039.
- OMAFRA Factsheet *Calibrating Airblast Sprayers,* Order No. 10-047.
- OMAFRA Factsheet *Adjusting, Maintaining and Cleaning Airblast Sprayers,* Order No. 10-069.
- OMAFRA Factsheet *Pesticide Drift from Ground Applications,* Order No. 11-001.
- *Airblast 101 Course Materials* - The goal of this course is to provide participants with the basic tools to allow them to apply pesticides and plant growth modifiers in an effective, economic and environmentally responsible manner. For more information contact jason.deveau@ontario.ca

Spraydrift

Do you know what pesticide drift looks like or what you can do about it? OMAFRA and CropLife Canada have created two short videos with innovative visual demonstrations using dyes and night-spraying to show what drift actually looks like. See how spray particles behave and discover what changes can be made to your spray program to greatly reduce the risk of pesticide drift. Learn more at *www.ontario.ca/spraydrift*.

11. Reduced-risk Pesticides and Biopesticides

Reduced-risk Pesticides and Biopesticides

Reduced-risk products

Reduced-risk pesticides are products that present a reduced risk to human health and/or the environment, when compared to alternatives (Table 11-1. *Examples of Reduced-Risk Pesticides Used for Fruit Crops in Ontario,* on this page). Reduced-risk designations do not mean the products have no risk, but rather that they have slightly less risk when compared to other products with the same use pattern. These pesticides are of interest because they have some of the following characteristics:

- lower impact on human health
- lower toxicity to non-target organisms
- lower potential for contamination of groundwater, surface water or other valued environmental resources
- low use rates
- low potential for pest resistance
- compatibility with Integrated Pest Management (IPM) practices

Some of the possible challenges with using reduced-risk pesticides are:

- more frequent applications needed to control pests
- slower acting than conventional pesticides
- may provide suppression but not control of the pest
- more expensive than conventional pesticides
- fewer pests controlled

Table 11-1. Examples of Reduced-risk Pesticides Used for Fruit Crops in Ontario

Product name	Active ingredient	Type of product/use
Acramite 50 WS	bifenazate	miticide
Allegro 500 F	fluazinam	fungicide
Apogee	prohexadione calcium	plant growth regulator
Apollo SC	clofentezine	miticide
Assail 70 WP	acetamiprid	insecticide
Confirm 240 F	tebufenozide	insecticide
Delegate WG	spinetoram	insecticide
Elevate 50 WDG	fenhexamid	fungicide
Flint 50 WG	trifloxystrobin	fungicide
Intrepid 240 F	methoxyfenozide	insecticide
Kanemite 15 SC	acequinocyl	miticide
Lance WDG Cantus WDG	boscalid	fungicide
Oberon	spiromesifen	miticide
Quintec	quinoxyfen	fungicide
Ridomil Gold 480 SL	metalaxyl	fungicide
Rimon 10 EC	novaluron	insecticide
Scala SC	pyrimethanil	fungicide
Scholar 230 SC	fludioxonil	fungicide
Silencer 120 EC Matador 240 EC	lambda-cyhalothrin	insecticide
Success 480 SC Entrust 80 W GF-120 NF	spinosad	insecticide
Switch 62.5 WG	cyprodinil + fludioxonil	fungicide
Vangard 75 WG	cyprodinil	fungicide

Sources: Pest Management Regulatory Agency (PMRA) Reduced-risk Update Document RR2007-01 Update on Reduced-risk Pesticides in Canada, PMRA Reduced-risk Update Document RR2008-01 Update on Reduced-risk Pesticides In Canada and The Pest Management Regulatory Agency Initiative for Reduced-risk Pesticides (Regulatory Directive DIR2002-02).

Biopesticides

Biopesticides are derived from natural materials such as animals, plants, and bacteria. In Canada, biopesticides are divided into two major classes, microbial pesticides and biochemical pesticides.

Microbial pesticides contain a beneficial bacterium, fungus, virus or protozoan as the active ingredient. They are relatively specific to their target pest. Examples include the various subspecies and strains of *Bacillus thuringiensis.*

Biochemical pesticides are naturally-occurring substances and/or manufactured molecules that resemble naturally-occurring substances. They generally control pests by different mechanisms than conventional pesticides, such as disrupting insect mating (e.g. Isomate) or by making crops unsuitable for feeding (e.g. Surround). While many biopesticides are less toxic and pose a lower risk than conventional pesticides, some can be quite toxic.

Biopesticides can be helpful additions to IPM programs, but they may not provide the same high level of control as conventional pesticides. Biopesticides are often labelled for suppression, or partial suppression of pests (see Table 2-6. *Efficacy Ratings for Insecticides, Miticides* *and Fungicides,* page 13). To improve control, combine their use with other pest control tactics (e.g. cultural, mechanical, biological control).

Although many biopesticides are formulated, packaged and applied in a very similar fashion to conventional pesticides, the active ingredients are different. They have unique, specialized modes of action which make them more susceptible to numerous biological and environmental factors. Biopesticides often have limited residual activity, and repeat applications of the product may be necessary to maintain efficacy.

Table 11-2. *Characteristics of Biopesticides Registered on Fruit Crops,* page 244, provides details on important factors that affect the success of biopesticides. These factors include spray timing and environmental conditions such as sunlight and rain. Chlorination, temperature and pH of water used for spraying can affect the viability of some biopesticides. For example, some bioinsecticides must be ingested soon after application and therefore must be applied only when the target pest is actively feeding. Others are effective only against young insects, or early in a pest infestation. Biopesticides may degrade, germinate or otherwise be altered when mixed with spray water, and should be applied immediately after preparation. Certain precautions may be necessary for storage. Some products must be kept frozen, or have a limited shelf life.

Details and specific application instructions for biopesticides can be found on the product label. Knowing the specific requirements for these products can improve the success of biopesticide application.

Biopesticides for Disease Control

Streptomyces lydicus (Actinovate)

Actinovate is a microbial pesticide registered on strawberries for suppression of botrytis fruit rot and powdery mildew and reduction in symptoms of anthracnose fruit rot. Before using this product, consider whether suppression, or reduction in damage, will be adequate in a commercial crop.

The active ingredients are spores of *Streptomyces lydicus,* a naturally occurring bacterium commonly found in soil. Researchers think that this bacterium helps protect plants by growing over the plant surface, parasitizing fungal pathogens and producing antibiotics that are detrimental to these fungal diseases. Applications should begin when conditions favour disease development. Additional applications every 7–14 days will be required. This product can be stored at room temperature (21–26°C), but should not be frozen or exposed to very high temperatures. Spray mixtures should be applied within 4 hours of preparation. Actinovate contains live bacteria and should not be used with bactericides.

When using Actinovate, always leave an untreated plot to evaluate the efficacy of this product.

Bacillus subtilis (Serenade ASO, Serenade MAX)

Serenade products are registered for the suppression of a variety of diseases on fruit crops. Before using these products, consider whether suppression will be adequate in a commercial crop.

The active ingredient is *Bacillus subtilis,* which colonizes plant parts and helps prevent disease microorganisms from becoming established. These biopesticides may not provide complete control and should be used as part of an integrated disease suppression program, which includes cultural controls and other tactics. Serenade is most effective when applied during the early stages of disease development. Rotate this product with other fungicides when conditions are conducive to heavy disease pressure.

Crop specific strategies

Apple – For suppression of fire blight, begin applications at early (1–5%) bloom at the beginning of a warming trend, and follow with a streptomycin spray 2 or 3 days later if warm temperatures continue to favour blossom infection. Serenade should be used as part of an integrated fire blight suppression program, which includes a risk assessment model, as well as cultural controls and the use of streptomycin sprays when necessary. Serenade Max is also registered for suppression of powdery mildew and scab on apple.

Berry crops – Serenade provides suppression rather than control of botrytis grey mould and powdery mildew, when multiple applications are made before disease symptoms appear. Expect best control when Serenade is used in rotation with other, more effective products. Large ranges in rates are labelled for berry crops, with little information on when to use high or low rates. When using Serenade, always leave an untreated area to evaluate the efficacy of this product.

Grapes – Serenade provides protection from botrytis bunch rot but has no post-infection activity. It provides suppression of powdery mildew.

Potassium bicarbonate (MilStop Foliar Fungicide)

MilStop is a biochemical pesticide registered for suppression of powdery mildew on stone fruits and control of powdery mildew on grapes. The active ingredient, potassium bicarbonate, is a colourless, odorless, powder. It acts as a contact fungicide that kills the powdery mildew fungus by pulling water from its spores and cell walls. It also alters the pH on the leaf surface, which inhibits enzymes needed for formation of fungal cell walls, providing the plant with residual protection. Do not tank mix with pesticides or fertilizers that are not compatible with mild alkaline solutions. Do not add surfactants or wetting agents and do not adjust spray solution pH after mixing MilStop.

Pantoea agglomerans (Bloomtime Biological FD)

Bloomtime is registered for suppression of fire blight on apples, pears, Saskatoon berries and raspberries. Bloomtime is based on a strain of the non-pathogenic bacteria, *Pantoea agglomerans*, which is antagonistic to the bacteria that causes fire blight. It colonizes the same areas of blossoms as the fire blight bacteria, but without causing any damage or plant disease. Once present, it competes with the fire blight bacterium for nutrients, keeping the number of harmful bacteria low. This product is preventative rather than curative – its efficacy depends on being applied and allowed to colonize plant surfaces before infection by the fire blight bacteria.

This product only suppresses fire blight, providing approximately 60% control without additional measures, and should not be the only product in a pest control program. Bloomtime should be part of an integrated fire blight management program that includes monitoring, use of a risk assessment model, cultural controls and streptomycin sprays. Suppression of the fire blight bacteria can still be very beneficial. Lower numbers of colonizing fire blight bacteria will result in more effective and fewer streptomycin applications in some orchards. Fewer applications of streptomycin can help reduce the risk of development of stretptomycin-resistant fire blight bacteria.

Pseudomonas syringae (Bio-Save 10 LP)

The active ingredient in Bio-Save, *Pseudomonas syringae*, is a naturally occurring bacterium that is normally present on the surface of produce. It is registered for post harvest suppression of blue mold and botrytis gray mold on cherries, apples and pears, and for the suppression of mucor rot on apples and pears. The Bio-Save bacterium enters wounds on fruit where pathogen spores live and competes with plant pathogens for nutrients. At produce storage temperatures, it can outgrow the pathogens.

Thorough coverage of fruit with this product is critical to optimize results, as the active ingredient must enter wounds to be effective. This product should be applied prior to disease development. It is recommended that the product be applied as an aqueous drip, drench or spray after washing and rinsing, but before waxing. In all cases, spray mixtures need to be agitated to keep the bacteria in suspension. Recycled dip or drench suspensions will require addition of fresh materials. Bio-Save should not be applied in wax, as ingredients in wax can degrade it when directly added to the coating. For optimal control, this product should be applied as soon as possible after picking fruit (within 24 hours). Bio-Save can be stored at 4°C for up to one year from the date of manufacture, or at room temperature (23°C) for up to three weeks from the date of manufacture.

Table 11-2. Characteristics of Biopesticides Registered on Fruit Crops

This information does not replace that included in product labels. Always check the label before use.

Product Name	**Target Pest Stage**	**Spray Timing**	**UV Effects**[1]	**Rain Effects**[2]	**Repeat Applications**[3]	**Life of Spray Mix**[4]	**Storage**		**Other Comments**
							Temp	**Length**[5]	
Insect/Mite Controls									
***Bacillus thuringiensis* (Bt)**									
Bioprotec 3P	Young larvae	Early in pest infestation	Yes	Yes	Yes	12 hours	4–25°C, cooler preferred	12 months	Spray water pH should be less than 8. Agitate during spraying. Must be ingested to be effective – spray when and where pests are actively feeding.
Bioprotec CAF	Young larvae	Early in pest infestation	Yes	Yes	Yes	12 hours	0–15°C, cooler preferred	6 months	Spray water pH should be less than 8. Agitate during spraying. Must be ingested to be effective – spray when and where pests are actively feeding.
Dipel 2X DF	Young larvae	Early in pest infestation	Yes	Yes	Yes	12 hours	0–25°C	24 months	Spray water pH should be less than 8. Agitate during spraying. Must be ingested to be effective – spray when and where pests are actively feeding.
Dipel WP	Young larvae	Early in pest infestation	Yes	Yes	Yes	12 hours	0–25°C	24 months	Spray water pH should be less than 8. Agitate during spraying. Must be ingested to be effective – spray when and where pests are actively feeding.
Foray 48BA	Young larvae	Early in pest infestation	Yes	Yes	Yes	72 hours	< 25°C		Spray water pH should be less than 8. Agitate during spraying. Must be ingested to be effective – spray when and where pests are actively feeding.
***Cydia pomonella* granulosis virus**									
Virosoft CP4	Eggs/young larvae	Depends on control strategy	Yes		Yes		4°C		Must be applied before larvae have entered fruit. Must be ingested to be effective – apply where/when larvae are feeding.
CYD-X	Eggs/young larvae	Depends on control strategy	Yes	Yes	Yes		4°C	12 months	Must be applied before larvae have entered fruit. Must be ingested to be effective – apply where/when larvae are feeding. Use non-chlorinated water at pH near 7.0 in the spray tank.

[1] UV Effects – Active ingredient may be inactivated/broken down by sunlight or is more effective when conditions favour slow drying. Spray in early morning, early evening or when cloudy.

[2] Rain Effects – Efficacy is reduced or product is readily washed off by rain. Avoid application when significant rainfall is imminent. Do not apply to foliage wet to the point of runoff.

[3] Repeat Applications – If yes, repeat applications are usually necessary to achieve/maintain pest suppression or control.

[4] Life of Spray Mix – Refers to maximum length of time between preparing and spraying a diluted spray mix.

[5] Storage Length – Entries refer to maximum time product can be stored from date of manufacture. Where there is no information listed, refer to best before date on product.

Blank cell means information is unavailable.

Table 11-2. Characteristics of Biopesticides Registered on Fruit Crops (cont'd)

Product Name	Target Pest Stage	Spray Timing	UV Effects[1]	Rain Effects[2]	Repeat Applications[3]	Life of Spray Mix[4]	Storage		Other Comments
							Temp	Length[5]	
Insect pheromones									
Isomate-GBM Plus	Adults	Prior to adult activity			No		4°C		
Isomate-CM/OFM TT (twin tube)	Adults	Prior to adult activity			Possibly		4°C		No reapplication for codling moth. May need another product for season-long control of oriental fruit moth. May require supplemental insecticides where population pressure is high.
Isomate-M 100	Adults	Prior to adult activity			Possibly		4°C		May need additional products for long season crops.
Isomate-M Rosso	Adults	Prior to adult activity			No		4°C		
Isomate-P	Adults	Prior to adult activity			No		4°C		
Kaolin clay									
Surround WP	Depends on pest	Early in pest infestation		Yes	Yes		Keep dry		Agitation important, increase water volume/droplet size under hot, dry conditions. Do not use with anti-foaming agents, white mineral particulate products, spreader/stickers or summer oils. Efficacy depends on complete coverage of susceptible plant parts.
Soap									
Opal Insecticidal Soap	All stages	Early in pest infestation	Yes		Yes	Spray tank mixes ASAP			Water hardness should be less 300 ppm. Agitate tank mixes during spraying. Do not mix with Manzate and Dithane. Do not use within 3 days of sulphur. Do not apply to stressed plants. Product must directly contact pest to be effective.
Safer's Insecticidal Soap	All stages	Early in pest infestation	Yes		Yes				Do not use with hard water. Product must directly contact pest to be effective.

[1] UV Effects – Active ingredient may be inactivated/broken down by sunlight or is more effective when conditions favour slow drying. Spray in early morning, early evening or when cloudy.

[2] Rain Effects – Efficacy is reduced or product is readily washed off by rain. Avoid application when significant rainfall is imminent. Do not apply to foliage wet to the point of runoff.

[3] Repeat Applications – If yes, repeat applications are usually necessary to achieve/maintain pest suppression or control.

[4] Life of Spray Mix – Refers to maximum length of time between preparing and spraying a diluted spray mix.

[5] Storage Length – Entries refer to maximum time product can be stored from date of manufacture. Where there is no information listed, refer to best before date on product.

Blank cell means information is unavailable.

Table 11-2. Characteristics of Biopesticides Registered on Fruit Crops (cont'd)

Product Name	Target Pest Stage	Spray Timing	UV Effects[1]	Rain Effects[2]	Repeat Applications[3]	Life of Spray Mix[4]	Storage		Other Comments
							Temp	Length[5]	
Disease Controls									
Streptomyces lydicus									
Actinovate SP	Early stages of disease development	When conditions are conducive to disease development	No	Do not apply before heavy rain	Yes	4 hours	Ideal: 21-26°C, do not freeze/ overheat	12 months	Do not use with bactericides at levels greater than 75 ppm. Clean equipment before use. Thorough coverage is important.
Bacillus subtilis									
Serenade ASO	Before/ early stages of disease development	When conditions are conducive to disease development			Yes	Do not let sit for prolonged periods	room temperature	9 months	Use higher rates or shorter intervals when conditions are conducive to rapid disease development. Do not combine with other pesticides, adjuvants, surfactants or fertilizers. Thorough coverage important.
Serenade MAX	Before/ early stages of disease development	When conditions are conducive to disease development			Yes	Do not let sit for prolonged periods	≤ 25°C	12 months	Use higher rates or shorter intervals when conditions are conducive to rapid disease development. Continuous agitation during spraying is important.
Potassium bicarbonate									
MilStop Foliar	Early stages of disease development	At first sign of disease		Shorten intervals when rainy or humidity is high	Yes				Use high rate if disease pressure is moderate to high. Do not acidify spray solution. Do not mix with other chemicals not compatible with mild alkaline solutions. Thorough coverage important.
Pantoea agglomerans									
Bloomtime Biological FD	Before disease is present	1st application at 15-20% bloom			Yes	24 hours	-10 to 0°C		Do not use close to copper applications . Thorough coverage important.
Pseudomonas syringae									
Bio-Save 10 LP	Before disease is present	Ideally within 24 hrs of picking					4°C 23°C	1 year 3 weeks	Apply prior to waxing fruit. Thorough coverage is important. Agitate suspensions during application.

[1] UV Effects – Active ingredient may be inactivated/broken down by sunlight or is more effective when conditions favour slow drying. Spray in early morning, early evening or when cloudy.

[2] Rain Effects – Efficacy is reduced or product is readily washed off by rain. Avoid application when significant rainfall is imminent. Do not apply to foliage wet to the point of runoff.

[3] Repeat Applications – If yes, repeat applications are usually necessary to achieve/maintain pest suppression or control.

[4] Life of Spray Mix – Refers to maximum length of time between preparing and spraying a diluted spray mix.

[5] Storage Length – Entries refer to maximum time product can be stored from date of manufacture. Where there is no information listed, refer to best before date on product.

Blank cell means information is unavailable.

Biopesticides for Insect Control

Kaolin Clay (Surround WP)

Surround WP is based on particle film technology, which protects crops from certain insects, heat stress and sunburn by coating plant surfaces with a white particle barrier film. Surround WP is registered in Canada for use in fruit and other crops against several insect pests. The active ingredient is kaolin clay, a non-toxic compound. The film serves as a barrier between the pest and the plant, either repelling or disorienting insects that come into contact with it, or making the host plant unrecognizable for feeding.

Thorough spray coverage of fruit and leaves is essential for good efficacy. For best results, apply Surround before pests are present or early in a pest infestation. Light to moderate rain will help to distribute the particle film on plant surfaces without removing large amounts of residue. Re-application may be necessary after a heavy rainfall. New growth, heavy wind or overhead irrigation can also reduce film coverage. Surround should not be mixed with spreaders, stickers or anti-foaming agents. Do not spray this product when bees are active.

Surround will leave a white film on plant parts. For fruits that will not be washed and waxed, apply early in the season, and stop applications when fruit is sizing.

Crop specific strategies

Apples – In orchards treated with Surround, use starch iodine tests to monitor fruit maturity in the last two weeks of crop development. Check with your packer before using Surround on fruit for export to Europe. Applications at petal fall may interfere with leaf miner parasitism, requiring additional control measures.

Grapes – Surround may delay sugar accumulation. Closely monitor harvest parameters to determine optimal time to harvest.

Raspberries and Strawberries – Avoid application when fruit is present. Surround is most useful for potato leafhopper control in non-bearing plantings.

Bacillus thuringiensis var. *kurstaki* (Bioprotec CAF, Bioprotec 3P, Dipel 2X DF, Dipel WP, Foray 48BA)

Bacillus thuringiensis products are registered on pome fruits, stone fruits, grapes and berry crops for control of various caterpillars, including leafrollers and fruitworms. The active ingredients in these products are proteins produced by the bacteria *Bacillus thuringiensis*, or *Bt*. *Bt.* is commonly found in soil, dead insects, plants and other locations. There are many subspecies, and some have proteins that are toxic to specific groups of insects. The *kurstaki* subspecies is toxic only to caterpillars, although it is not equally effective against all species of caterpillar. Insects affected by *Bt.* stop feeding within a few hours and die in 2–5 days.

Bt. products must be consumed by the insect to be effective. Consequently, they must be applied to plants where and when caterpillars are actively feeding. Because some caterpillars feed in cryptic locations, thorough coverage is essential. The active ingredient in *Bt.* is sensitive to ultraviolet radiation, and efficacy may be reduced after prolonged exposure to sunlight. To maximize the effectiveness of these products, apply in the evening, on cloudy days, and when no rain is forecast for 24–48 hours after application. Evening applications may be particularly important if the target pest feeds predominantly at night. Younger larvae are more susceptible to these products, so applications should be targeted at early instar larvae. Because there is not a long residual activity with these products, repeat applications will often be required to obtain effective control.

For best results using *Bt.* products, acidify spray tank solution to below pH 7. Do not apply in high volumes of water. For example, use no more than 600 L water/ha for Bioprotec and Foray.

Crop specific strategies

Apples – Due to its photosensitivity, *Bt.* products are often used early in the season prior to petal fall. However, they can be used later in the season to manage obliquebanded leafroller where populations are low.

Grapes – When hatching, larvae must consume egg shell treated with *Bt.* in order for the product to be effective. Apply *Bt.* to coincide with grape berry moth egg hatch, earlier than the traditional timing for organophosphate and pyrethroid insecticides.

Insecticidal soaps – potassium salts of fatty acids (Opal Insecticidal Soap, Safer's Insecticidal Soap)

Opal and Safer's insecticidal soaps are registered for use on a wide variety of fruit crops for control of aphids, scale and other soft-bodied insects and mites.

Soaps work by coating the bodies of soft-bodied insects, smothering them and interfering with their cuticles. They must be sprayed directly onto the target insect and have no effect once the soap deposits have dried. Thoroughly cover all plant parts, including under leaf surfaces, where soft-bodied insects such as aphids are found. Apply these products when drying conditions are slow, in the early morning or evening, or when it is cloudy. Avoid using hard water with insecticidal soaps.

Insecticidal soaps often will not give complete control because it is difficult to cover 100% of the pests present in a crop. They are generally most effective when pest populations are small. Combine the use of insecticidal soaps with other pest management techniques (other chemicals or cultural controls). Repeated application of these products may be necessary; however take care to avoid phytotoxicity when using insecticidal soaps. To avoid damage, do not allow soap to accumulate at the base of fruits.

Do not apply within 3 days of a sulfur product.

Cydia pomonella granulosis virus (Virosoft CP-4 , CYD-X)

Virosoft and CYD-X are microbial insecticides registered for control of codling moth in apples. The active ingredient is the *Cydia pomonella* granulovirus, a naturally occurring pathogen which is highly specific to codling moth larvae. When larvae ingest virus particles, the virus invades through the gut wall, attacking and degrading the insect's tissues. The insect eventually stops feeding, becomes discoloured, grows swollen and dies a few days later, essentially liquefying into a mass of virus particles. Since larvae must ingest the virus to be infected, damage to fruit may occur before the insect dies.

Several factors are important when determining how to use these products:

- Virus must be consumered for it to be effective.
- Death may take several days.
- The virus is most effective against younger larvae.
- This product is very sensitive to sunlight, so applications should be made late in the day or when it is cloudy.
- Virus particles do not persist long in the environment, so sprays will be effective for only a week or so.

Apply granulosis virus when young larvae either are on the surface of the fruit or will encounter the virus before entering the fruit. The best method is to have the virus present on the eggs as they hatch, so that hatching codling moth larvae consume the virus particles as they eat their way out of the egg. If granulosis virus is to be the only control, apply the first application at 139 DDC, base 10°C after biofix (first sustained moth catch), followed by subsequent applications to cover the egg hatch period.

These products are most effective when used in conjunction with other materials. For organic growers, granulosis virus together with mating disruption may provide acceptable control. Conventional growers may opt to rotate this active ingredient with other active ingredients for resistance management. One option would be to apply a chemical insecticide at the start of egg hatch (139 DDC, base 10°C after biofix), with the virus serving as the second spray, when more eggs are present to be covered by the virus. Follow this with another rotation of insecticide and virus, or simply with additional applications of the virus.

Another option is to target only the first generation with the virus product. Although some virus-infected larvae will not die immediately, very few of these larvae will actually pupate and emerge as summer generation adults. Using this active ingredient for the first generation greatly reduces the size of the summer generation, which can be controlled with other pesticides.

Using Mating Disruption in Fruit Crops

Insect pheromones developed to reduce populations of certain pests are considered biopesticides by the Pest Management Regulatory Agency.

Many female insects emit volatile chemicals known as sex pheromones to attract males of the same species. Mating disruption products release large quantities of synthetically produced sex pheromone into the crop atmosphere, which confuses male insects and interferes with mate location. Mating is either delayed or prevented because the probability of males finding females is reduced. Consequently, fewer larvae develop and crop damage is reduced.

Managing insects using mating disruption is very different from using insecticides. Mating disruption products are highly specific, targeting a single or few very closely related insect pests. They do not kill the target pest, nor will they control immigration of mated females from untreated or poorly managed areas. Mating disruption products must be applied before adults begin to fly. Late applications allow some mating to occur, with subsequent damage to the affected crop. Where pest populations are moderate to high, some mating will occur due to random chance encounters between males and females. Mating disruption works most effectively where the target pest populations are low.

When applied to a block over multiple years, mating disruption products reduce overall population pressure so that insecticides may be reduced or, in some cases, eliminated.

The many advantages of using mating disruption include improved safety to humans and non-target organisms, resistance management, and no re-entry or pre-harvest intervals.

Limitations include a requirement for large regularly shaped blocks, low to moderate pest pressure, and the need for insecticides for other orchard or vineyard pests.

Wild or unsprayed hosts (i.e. wild grapes, abandoned orchards) within 300 m of areas where mating disruption is used can be major sources of mated female moths. Moths moving from these untreated areas into treated areas may significantly reduce the level of control achieved.

To overcome this problem:

- Treat entire blocks with pheromones or practise area-wide management to reduce border effects.
- Treat infestation sources with a registered insecticide or with appropriate mating disruption product (e.g. treat a strip at least 50 metres wide nearest the treated field).
- Treat border rows of the pheromone-treated block with insecticide.

There are several mating disruption products available for use in orchards and vineyards. While general use strategies remain similar for each, some are more effective than others at keeping damage at or below economically acceptable thresholds. As with insecticides, mating disruption programs are not stand-alone strategies for all pests. Every orchard has different pest pressures, which affects the successful integration of mating disruption into IPM programs.

For more information, see OMAFRA Factsheet, *Mating Disruption for Management of Insect Pests,* Order No. 03-079.

Using mating disruption to control oriental fruit moth (Isomate-M Rosso and Isomate-M 100)

These products help to manage oriental fruit moth (OFM) in peaches and apples in Ontario when applied to large areas with low target pest populations.

- If using mating disruption products for the first time or in areas of high pest pressure, use an insecticide to manage the first generation of OFM.
- Monitor treated blocks with OFM pheromone traps to ensure moths are not being captured – a sign of some level of failure or weakness in the mating disruption program.
- Routinely look for signs of damage from OFM.
- If unacceptable levels of damage have occurred, use insecticides until the source of the failure has been determined.
- For late-harvest varieties located near untreated areas or host crops, application of insecticides may be required.

For more information: OMAFRA Factsheet, *Mating Disruption for Management of Oriental Fruit Moth in Stone and Pome Fruit,* Order No. 04-029.

Using mating disruption to control codling moth and oriental fruit moth with the twin tube (Isomate-CM/OFM TT)

Mating disruption alone will not provide adequate control of codling moth (CM) in most commercial orchards. When mating disruption is used together with existing IPM programs, pest populations and pesticide use can be reduced over a number of seasons. Depending on site pest pressure and monitoring, insecticides for one or both generations of CM are recommended to avoid unacceptable damage at harvest.

- During the first year of using mating disruption for CM, follow a standard spray program for both generations and monitor extensively for this pest.
- In the second year of a mating disruption program, and where populations are low, limit insecticides to the first generation.
- In subsequent years, use results from monitoring and damage assessments to determine if insecticide applications can be reduced further when mating disruption products are used.

Many of the new reduced-risk products and the granulosis virus (Virosoft, CYD-X) work very effectively together with mating disruption to help reduce CM populations to levels where insecticide use may be reduced in subsequent years. Timing of insecticides must be based on a biofix determined at a point outside the treated orchard.

Monitoring for codling moth flight in mating disruption blocks

- Codling moth flight can be monitored using special supercharged lures (10× lures) loaded with high rates of pheromones that capture males even in disrupted blocks. These traps serve to help set the biofix point for DD accumulations used to time supplemental insecticide treatments.
- Traps should be placed in the upper portion of the canopy in disrupted blocks (same height as the mating disruption dispensers).
- Check traps at least once every week, preferably twice.
- Use a minimum of one trap per hectare, with traps located near high risk areas and borders (5–6 rows in).
- Thresholds for the application of insecticides are based on the number of moths captured per trap per week in disrupted blocks. As a general guideline, 3–5 moths per trap per week indicates a need for caution. More than 5 moths per trap per week indicates the need for insecticides to supplement control from mating disruption.

Damage assessments

- Conduct in-season visual assessments for fruit damage toward the end of each generation and whenever moths are caught in traps.
- Fruit damage can occur even when no moths are caught in traps.
- At the end of the first CM generation, examine a minimum of 500 fruit from throughout the orchard as well as in high risk and border areas.
- If damage exceeds 0.5%, insecticides are required for the next generation. Where damage is localized, insecticides may be directed to those areas and along borders.
- Continue to assess damage weekly (200 fruit) throughout the season, to ensure the pheromones are working and to allow for timely intervention with insecticides, if required.

Apply Isomate-CM/OFM TT (twin tubes) prior to CM emergence in the spring. Set dispensers in the upper third of the canopy, in a uniform a grid. In older orchards interplanted with small numbers of replacement trees, bias the application to adjacent larger trees. In sections with large numbers of interplanted rows, insecticides may be required to supplement control from mating disruption.

The dispenser is designed to provide activity for the entire season for CM. Codling moth drives application timing of Isomate-CM/OFM TT. While some OFM may have emerged prior to deployment of the dispensers, several petal fall insecticides for other insects have activity against OFM. Dispensers release sufficient pheromone to control OFM for up 90 days. Insecticides may be needed in late varieties when high OFM populations exist or when immigration from untreated blocks late in the season may occur. See *Using mating disruption to control oriental fruit moth (Isomate-M Rosso and Isomate-M 100)*, page 249, for additional information on monitoring for OFM in disrupted blocks.

Using mating disruption to control grape berry moth (Isomate-GBM Plus)

Mating disruption works best in vineyards with low grape berry moth (GBM) populations. Avoid using mating disruption next to vineyards with known high populations of grape berry moth. Vineyards should be at least 2 ha in size.

To use Isomate-GBM Plus, place the recommended rate of pheromone dispensers uniformly through the vineyard prior to, or at the onset of first flight of moths in spring. Delayed application results in increased mating and reduced control.

- Attach dispensers securely to the upper training wire close to the vines.
- Wear gloves when you apply pheromone dispensers to avoid cross-contamination with other pheromone products.

Conduct damage assessments throughout the season to ensure that GBM are adequately controlled. Monitor for other sporadic pests such as leafhoppers, mites and spring feeding caterpillars to determine if insecticides are needed.

Monitoring for grape berry moth

- Use five pheromone traps for vineyards up to 5 ha in size. These traps are used as sentinels: captures of moths in pheromone traps should be very low to zero in vineyards using mating disruption.

- Place traps along a line that transects the vineyard or at the four corners of the vineyard. Place at least one extra trap along the windward edge of the vineyard.

- Where vineyards are located adjacent to wooded areas, place traps within the border area at least 40 m apart.

- Bait the traps with commercial lures. Replace lures every 6 weeks or as directed by manufacturer.

- Inspect traps twice weekly on the same days each week and record the number of moths.

Damage assessments

- Closely inspect fruit weekly in the outer five panels and rows for infestation, especially on the windward side.

- If more than 5% of the grape clusters in this outer area are infested with grape berry moth larvae, continue sampling another five rows and panels in.

- If more than 5% of the grape clusters in the outer five rows but less than 5% of grape clusters in the inner five rows are infested, then apply an insecticide to the border of the vineyard. If more than 5% of grape clusters in the inner five rows are infested, apply an insecticide to the entire block.

Mating disruption technology prevents mating of grape berry moth adults. However, if mated female moths are present in unsprayed vineyards or wild grapevines within 100 m, they can migrate into the pheromone-treated vineyard and reduce the level of control achieved.

To prevent migration of mated females into pheromone-treated blocks, do one of the following:

- Treat the entire vineyard, not just sections, with pheromones.

- Treat sources of infestation with pheromone dispensers before moth flight(s).

- Treat sources of infestation with an insecticide for grape berry moth.

- Treat edges of the vineyard with insecticides for grape berry moth.

See OMAFRA Factsheet, *Mating Disruption for Management of Insect Pests,* Order No. 03-079, for more information.

Other Reduced-risk Products with Special Considerations

GF-120 NF Naturalyte Fruit Fly Bait

GF-120 NF is registered for control or suppression of various maggot pests in cherries, blueberries and apples. It is not considered a biopesticide, however it is similar to a biopesticide in having a unique formulation that requires special consideration to optimize efficacy. GF-120 contains spinosad, which is derived from the fermentation of the soil bacterium *Saccharopolysora spinosa.* The active ingredients in GF-120 are spinosad plus a feeding attractant that serves as a bait to draw adult flies to the product. Because the bait attracts insects to the spray deposits, only a small amount of insecticide is required. It has low toxicity to mammals and birds, but is toxic to adult flies of various pest species, exciting their nervous symptoms and causing death from exhaustion within 1–2 days of ingestion.

Large droplet sizes optimize the attractiveness and longevity of the bait. Apply this product using an all-terrain vehicle fitted with the appropriate sprayer and nozzle to ensure large droplets. GF-120 has relatively short residual activity in hot, dry conditions. This product loses effectiveness if exposed to rain or overhead irrigation. Re-apply every 7–10 days or after rainfall. Direct contact with spinosad is toxic to honeybees. Do not use these products when honeybees are actively foraging.

Crop specific strategies

Apples – Research conducted in Ontario has shown suppression of apple maggot in organic orchards. However, GF-120 does not provide adequate management of this quarantine pest in orchards where there is zero tolerance for damage. Monitor apple maggot emergence using sticky traps and apply GF-120, at a rate of 1.5 L per 6 L water, after the first fly is caught. To improve efficacy, prune trees to ensure penetration of the product to the cooler shaded, inner canopy where its residual activity may be prolonged. Uniform spray coverage of foliage is not critical.

Blueberries – Begin application when first blueberry maggot flies are trapped, or when berries begin to turn blue (about 2–3 weeks before fruit begins to ripen). Repeat application at least every 7–10 days.

Cherries – Spray as soon as traps indicate flies are present or 2–3 weeks before ripening.

Mineral oil (Purespray Green Spray Oil 13E)

Mineral oil is a highly refined petroleum product that is different from dormant oil. Dormant oil cannot be used interchangeably with mineral oil.

Mineral oil acts as an insecticide/miticide by suffocation and is effective only when the film deposited covers every scale, mite egg or mite. Therefore thorough coverage is important. Eggs are most vulnerable to control with oil just before hatching.

As a fungicide, mineral oil acts as both an eradicant and a protectant, providing the destruction of lightly established infections and providing modest protection for a short period of time. It is susceptible to wash-off and activity is significantly reduced by as little as 5 mm of rain. It provides an alternative mode of action in a disease control program, reducing the likelihood of resistance to fungicides with specific modes of action.

Cautions regarding mineral oil use

- Do not use oil within 48 hours of freezing temperatures.
- Do not use oil within 14 days of Captan or Maestro or any product containing sulphur.
- Do not spray oils while temperatures are very high (above 25°C), or burning may occur.
- Oils remove the waxy "bloom" from fruit surfaces, so should not be used within 60 days of harvest on fruit to be sold for the fresh market.
- Read the product label carefully for other precautions.
- Since not all fruit vareties have been tested for tolerance to Spray Oil 13E, first application of Spray Oil 13E should be limited to a small area of each variety to confirm tolerance prior to adoption as a general field practice.

Crop specific strategies

Apples – Oil may cause bark injury on Red Delicious, Empire and Mutsu. Oil will provide control of overwintering ERM and suppression of summer populations of ERM and powdery mildew.

Grapes – Oil provides significant eradicant activity against existing infections. However, this product works strictly by contact, hence thorough spray coverage is essential.

Do not tank mix oil and copper more than once per season. Do not use copper and oil together with fruit present. Do not use oil within 14 days before or after Captan or Maestro application. In research trials two or more applications of oil near veraison have resulted in a modest but consistent lowering of Brix values (1° to 2°) at harvest. In contrast, applications before this period generally have had no effect on Brix values.)

Stone Fruit – Oil may be used for cherry mildew management between petal fall and pit hardening. Do not apply between pit hardening and harvest. Certain varieties of plums and prunes may be injured by oil sprays. Check for tolerance prior to treatment. Do not apply oil to sensitive varieties. Do not apply to trees under moisture stress. Post harvest sprays may be made to maintain control and reduce overwintering powdery mildew pressure.

12. Managing Pest Resistance

Pest Resistance to Insecticides, Fungicides, Miticides

Random natural mutation may result in a small proportion of a population that is resistant to a particular chemical or group of chemicals. When a population is exposed to a pesticide, the resistant individuals survive and the susceptible individuals are killed. The resistant survivors then multiply and pass their resistant traits on to the next generation. With each consecutive spray, the proportion of resistant individuals increases, replacing the susceptible ones in the population. Once the resistant population dominates, the pesticide has lost efficacy. A pest population is considered resistant when it is able to survive exposure to rates of a pesticide that previously controlled it.

Resistance to one pesticide can result in resistance to other pesticides within a chemical family or from a different one, especially pesticides with similar action sites. This is called **cross-resistance**. It develops in the absence of independent selective pressure against each pesticide, but rather when exposure to one pesticide causes selection for resistance in others.

Multiple resistance occurs when a pest is resistant to pesticides from different families or sites of action at the same time. It begins to develop through selective pressure or repeated exposure to the new pesticide, independent of resistance previously developed to one or more other pesticides.

Multiple resistance and cross-resistance create serious challenges to the success of integrated resistance management strategies.

Pest control failures are not necessarily caused by resistance. Other factors should be considered, including: product selection and timing, water volume, rate, sprayer calibration, coverage, pH in spray tank water, time required for knockdown of the pest, and weather conditions.

Assessing resistance risk

The development of resistance depends on characteristics of both the pest and the group of pesticides involved. Table 12-1. *Factors Favouring the Development of Resistance*, on this page, describes situations where resistance is most likely to occur.

Resistance can develop very quickly for some pesticides. If a product is prone to resistance, do not use the product repeatedly unless it is used in rotation or combination with different products from a different chemical group.

Resistance Management Strategies

General resistance management strategies

- Follow an integrated pest management program that makes use of a variety of different pest control strategies, including monitoring and crop rotation, biological, and chemical control options.

- Spray only when necessary. Use established thresholds where available.

- Spray at the best timing for the pest and the product you are using.

- Apply registered products as directed, with a well calibrated sprayer.

- Read the product label. New products include resistance management recommendations on the label.

Table 12-1. Factors Favouring the Development of Resistance

Characteristics of a pest that is more likely to develop resistance	Characteristics of the pesticide or use pattern where resistance is likely to develop
• has prolific life cycle, with many generations per year, and/or multiplies very quickly	• has persistent residues, exposing multiple generations to residues from a single spray
• has a pre-existing resistance to other products in the same family	• is toxic to beneficials as well as the pest
• has a narrow host range, spending entire life cycle on one crop	• has specific mode of action that works on a single site
• does not migrate between crops or regions, so the gene pool is not diluted	• is used at excessive or deficient rates or improper timing

- Know the active ingredient of a pesticide. Many chemicals with the same active ingredients are marketed under different brand names. For example, the insecticide permethrin is marketed under the brand names Pounce and Perm-Up.

- Know the mode of action. Different chemicals may also have the same mode of action. For example, both Assail and Admire have the same mode of action. To use Assail after Admire is equivalent to using Assail after Assail, since resistance to both chemicals develops at the same time. This can happen even if only one has been used repeatedly.

For a list of chemical groups and their modes of action, see Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action*, page 257 and Table 12-3. *Insecticide and Miticide Groups Based on Sites of Action*, page 258.

Managing resistance to fungicides

- Rotate products from different chemical groups. Do not exceed the recommended number of applications per season or sequential applications of a pesticide or group of pesticides.

- Tank mix products from different families. This is an accepted resistance management strategy for fungicides. Use only registered tank mixes (specified on the label).

- Apply fungicides before disease occurs. Follow disease prediction models when possible. Applications of fungicides after the disease is established are more likely to select for resistant populations of the pathogen.

- Know which fungicides are combinations of chemicals from more than one fungicide group (e.g. Pristine, Switch). It is important to rotate these fungicides with products from different groups for all active ingredients in the combination.

Not all fungicides are prone to resistance. Most fungicides that affect a wide range of different metabolic processes in fungi are not prone to the development of resistance. These fungicides are known as multi-site inhibitors and are designated with an M in the group number (Table 12-2. *Fungicide/Bactericide Groups Based on Sites of Action,* page 257). These products can be applied to fungal pathogens repeatedly without rotation without significant risk of resistance development. Coppers and streptomycin are exceptions to this with respect to bacteria. For example, bacteria causing fire blight or blister spot can develop resistance to these products.

The strategy for preventing fungicide resistance depends on:

- the resistance risk of the pathogen to a particular fungicide group
- the availability of rotation options

Two components of a resistance management strategy for a fungicide group include:

- the number of consecutive applications before rotating to a different family group
- the maximum number of applications per season

In some cases, a single fungicide group can control more than one pathogen. In this case, the maximum number of consecutive and total applications per season should be based on the pathogen with the highest risk of developing resistance. For high-risk pathogens with fungicide options from many groups, rotation to a different group is recommended after a single application of a resistance-prone fungicide, although this is not necessarily required by the label. For pathogens controlled by few registered fungicide families, the recommendation is to use no more than two consecutive applications of a resistance-prone fungicide and then alternate to a different fungicide family. When a product contains active ingredients from more than one family, each application counts as a use for each family.

Resistance management strategies by fungicide group and disease for Ontario fruit crops

These strategies reduce the risk for resistance development, and may be more stringent than label guidelines. Solo products have one active ingredient. Combination products have more than one active ingredient and are indicated with an asterisk (*).

Group 3: Sterol biosynthesis inhibitors, demethylation inhibitors (Funginex, Indar, Nova, Nustar, Mission, Topas, Inspire, Jade)

- Apple scab resistance to Nova and Nustar has recently been confirmed in Ontario. Avoid using these products in orchards with resistance.

- For apple scab and for powdery mildew in berries, use no more than two consecutive applications then rotate to a different fungicide group; use fungicides from this group no more than four times per season.

- For powdery mildew in grape and brown rot in stone fruit, use once and then rotate to a different group; use fungicides from this group no more than twice per season.

Group 7: Lance, Cantus, Pristine*

- For botrytis grey mould in berries, use no more than two consecutive applications then rotate to a different fungicide group. No more than 30% of total fungicides applied per season should include a solo or mixture product from this group. See Group 11 for recommendations for Pristine use.
- For powdery mildew in grape and brown rot in stone fruits use once and then rotate to a different group. Apply no more than twice per season as a solo or mixture product. See Group 11 for recommendations for Pristine use.
- Avoid using Pristine in apple orchards with documented resistance to Group 11 fungicides.

Group 9: Scala, Vangard, Switch*

- For apple and pear scab, use once then rotate to a different fungicide group. Use prebloom, no more than two applications per season.
- For botrytis grey mould in berries, use once then rotate to a different fungicide group. No more than 30% of total fungicides applied per season should include a solo or mixture product from this group.
- For botrytis bunch rot in grape and brown rot in stone fruit, use once then rotate to a different group. Use products from this group no more than twice per season.

Group 11: Strobilurins (Flint, Sovran, Cabrio, Pristine*, Tanos*)

- Apple scab resistance to Flint and Sovran has recently been confirmed in Ontario. Avoid using these products in orchards with resistance.
- For apple and pear scab, use no more than two consecutive applications then rotate to a different fungicide group. Use products from this group no more than three times per crop.
- For botrytis grey mould in berries use no more than two consecutive applications then rotate to a different fungicide group. No more than 30% of total fungicides applied per season should include a solo product from this group or no more than 50% of total fungicides applied per season if using combination products.
- For powdery mildew in grape and brown rot in stone fruit, use once and then rotate to a different group. Use fungicides from this group no more than twice per season as a solo or mixture product.

Group 12: Scholar, Switch*

- For *Botrytis* control in berries, use no more than two consecutive applications then rotate to a different fungicide group. No more than 50% of total fungicides applied per season should include a product from this group.
- For storage rots in tree fruit, do not make more than one post harvest application.

Group 13: Quintec

- For powdery mildew in strawberries, use no more than two consecutive applications then rotate to a different fungicide group. No more than 50% of total fungicides applied per season should include a product from this group.
- For powdery mildew in grape and stone fruits, use once and then rotate to a different group. Apply no more than twice per season.

Group 17: Elevate

- For botrytis grey mould in berries, use no more than two consecutive applications then rotate to a different group. Do not use more than four times per season.
- For botrytis bunch rot in grapevine and brown rot in stone fruits, use once then rotate to a different group. Do not use more than twice per season.

Group 43: Presidio

- For grape downy mildew, tank mix with a labelled rate of another fungicide registered for downy mildew, but with a different mode of action. Use once then rotate to a different group. Do not use more than twice per season.

Group U8: Vivando

- For grape powdery mildew, use once then rotate to a different group. Do not use more than twice per season.

Managing resistance to insecticides and miticides

- Rotate products from different chemical groups. Avoid sequential applications or repeated use of any pesticide or group of pesticides.
- For insects with discrete generations, manage each generation of an insect pest as separate units. Use products from a single chemical group to manage a given generation of a pest. If the pest emergence

or activity for that generation is prolonged, apply a second application of the same product. This exposes each generation to only one chemical group. Rotate to another chemical group (or groups) for subsequent generations. If re-treatments are necessary for a particular generation, choose a product in that same group.

- Avoid unnecessary or repeated applications of miticides and rotate between products in different chemical groups. Many labels limit the number of applications of a product to one per season. Consider a multi-year rotation of miticides, so that mites are not exposed to products with a similar mode of action more frequently that once every three to four years. The use of an annual preventative delayed dormant oil or summer oils may help to suppress mite populations and reduce the need for rescue miticides when numbers exceed the treatment threshold(s).
- Applications should be timed and directed to contact the most susceptible life stage of the pest.
- Avoid tank mixing different insecticides to manage a single pest as this increases the probability that the target pest population will develop multiple resistance. Alternating products, rather than tank mixing them, is the preferred strategy for insecticides and miticides.
- Consider area-wide resistance management programs, especially for pests of more than one crop.

Resistance management strategies by insecticide group for Ontario fruit crops

Group 1A, 1B & 2A

Resistance to these older, broad spectrum insecticides has occurred in various fruit pest populations in Ontario. Documented cases include resistance to organophosphates in spotted tentiform leafminer on apples, obliquebanded leafrollers on apples and pears, pear psylla on pears and oriental fruit moth on peaches, nectarines, pears and apples. Research from the University of Guelph and Agriculture & Agri-Food Canada has recently documented resistance development to organophosphates in Ontario and Quebec codling moth populations in apples.

Group 3: Ambush, Decis, Matador, Perm-Up, Pounce, Ripcord, Silencer, Up-Cyde (pyrethroids)

Present status of spotted tentiform leafminer and pear pyslla resistance is unknown given that resistance in these pests has not been monitored since the early 1990s. Previous studies demonstrate that spotted tentiform leafminer adults became resistant to all pyrethroids in many orchards in Ontario when exposed to repeated applications of these chemicals. Pear pyslla resistance to pyrethroids has been documented in western North America and some pear orchards in the Niagara peninsula. Resistance may occur in other parts of the province. Documented cases of resistance in populations of obliquebanded leafroller on apples have been found.

The repeated use of pyrethroid insecticides (more than once per season) is discouraged because of the potential for further resistance development and because pyrethroids are toxic to beneficial insects and mites.

Group 4: Calypso

Documented cases of tolerance to the neonicotinoid, Calypso has been found in some codling moth populations in Ontario and Quebec. Research is ongoing to determine if resistance to Group 4 is developing in apples.

Group 18 : Confirm, Intrepid

Documented cross resistance between organophospate insecticides and the growth regulators, Confirm and Intrepid have been found in some obliquebanded leafroller and codling moth populations, respectively, in Ontario. Where resistance is suspected for obliquebanded leafroller or codling moth, do not use Group 18, 1A or 1B. Always use one group of insecticides within the generation and rotate insecticide groups between generations. Consult the apple calendar for the appropriate timing of these products.

Group 5, 11, 15 & 28

There are no documented cases of resistance in Ontario for fruit crops. Use the basic principles of resistance management to ensure that insecticides in these groups work well in the future.

Resistance management strategies by miticide group for Ontario fruit crops

Group 6: Agri-Mek

There are no documented cases of resistant mite populations in Ontario to this group. Use resistance management principles. Apply this product early before threshold numbers are reached.

Group 10: Apollo

Isolated cases of mite resistance to Apollo have been found in Ontario. Resistance has occurred where Apollo has been applied repeatedly in one season, or applied too late in the season. To delay resistance to Apollo, do not use Apollo every year. Apply Apollo when the mite population is synchronous and in the first summer generation egg stage.

Group 20B, 21, & 25

There are no documented cases of resistant mite populations in Ontario. Use resistance management principles.

Group 23

There are no documented cases of resistant mite populations in Ontario. Use resistance management principles. These products work slowly so patient and careful monitoring is needed to asses the results.

Table 12-2. Fungicide/Bactericide Groups Based on Sites of Action

Group	Chemical family or group	Product name	Active ingredient (a.i.) (* indicates the a.i. that puts it in this group)
1	MBC	Mertect SC Senator 70 WP	thiabendazole thiophanate-methyl
2	Dicarboximide	Rovral WP	iprodione
3	DMI (this group is sometimes loosely known as sterol inhibitors)	Funginex DC Indar 75 WP Inspire Jade Nova 40 W Nustar Mission 418 EC Topas	triforine fenbuconazole difenoconazole propiconazole myclobutanil flusilazole propiconazole propiconazole
4	Phenyl amide	Ridomil Gold MZ 68WG Ridomil Gold 480 SL	metalaxyl* + mancozeb metalaxyl
7	Anilide carboxamide	Cantus WDG Lance WDG Pristine WG	boscalid boscalid boscalid* + pyraclostrobin
9	Anilinopyrimidine	Scala SC Switch 62.5 WG Vangard 75 WG	pyrimethanil cyprodinil* + fludioxonil cyprodinil
11	QoI (stobilurins belong in this group, but not all QoI fungicides are strobilurins)	Cabrio EG Flint 50 WG Sovran Pristine WG Tanos 50 DF	pyraclostrobin trifloxystrobin kresoxim-methyl boscalid + pyraclostrobin* cymoxanil + famoxadone*
12	Phenylpyrroles	Scholar 230 SC Switch 62.5 WG	fludioxonil cyprodinil + fludioxonil*
13	Aza-naphthalenes	Quintec	quinoxyfen
17	Hydroxyaniline	Elevate 50 WDG	fenhexamid
18	Antibiotic	Streptomycin 17	streptomycin
22	Benzamide	Gavel 75 DF	mancozeb + zoxamide*
27	Cyanoacetamide-oxime	Tanos 50 DF	cymoxanil* + famoxadone
29	Phenylpyridinamine	Allegro 500 F	fluazinam
40	Carboxylic acid amide	Revus	mandipropamid
43	Benzamide	Presidio	fluopicolide
44	Microbial	Serenade ASO Serenade MAX	*Bacillus subtilis* strain QST 713

Note: Fungicides in Group M are multi-site inhibitors.
NC = not classified.
U = unknown or non-specific.

Table 12-2. Fungicide/Bactericide Groups Based on Sites of Action (cont'd)

Group	Chemical family or group	Product name	Active ingredient (a.i.) (* indicates the a.i. that puts it in this group)
M	Inorganic	Copper 53 W Guardsman Copper Oxychloride Copper Spray Kumulus DF Lime Sulphur Microscopic Sulphur Microthiol Disperss	tri-basic copper sulphate copper from copper oxychloride copper from copper oxychloride sulphur lime sulphur sulphur sulphur
M	Dithiocarbamate	Dithane DG Dithane M45 Ferbam WDG Gavel 75 DF Penncozeb 75 DF Polyram DF Ridomil Gold MZ 68WG Thiram	mancozeb mancozeb ferbam mancozeb* + zoxamide mancozeb metiram metalaxyl + mancozeb* thiram
M	Phthalimide	Captan 80 WDG Folpan 80 WDG Maestro 80 DF	captan folpet captan
M	Chloronitrile	Bravo 500 Echo 720	chlorothalonil chlorothalonil
M	Guanidines	Equal 65 WP Syllit 400 FL	dodine dodine
NC	Biological	Actinovate SP Bio-Save 10 LP Bloomtime Biological FD	*Streptomyces lydicus* *Pseudomonas syringae* *Pantoea agglomerans*
NC	Bicarbonate	MilStop	potassium bicarbonate
U	Phosphonate	Aliette WDG	fosetyl al
U	Oil	Purespray Green Spray Oil 13E	mineral oil
U8	Benzophenone	Vivando	metrafenone

Note: Fungicides in Group M are multi-site inhibitors.
NC = not classified.
U = unknown or non-specific.

Table 12-3. Insecticide and Miticide Groups Based on Sites of Action

Group or subgroup	Chemical family or group	Product name	Active ingredient
1A[1]	Carbamate	Carzol SP Furadan 480 F Lannate Sevin XLR Plus Vydate L	formetanate hydrochloride carbofuran methomyl carbaryl oxamyl
1B[1]	Organophosphate	Cygon 480-AG Diazinon 50 WSP Diazinon 500 E Guthion 50 WSB Imidan 50 WP Lagon 480 E Lorsban 50 W Malathion 25 W Malathion 85 E Orthene 75% SP Sniper Zolone Flo	dimethoate diazinon diazinon azinphosmethyl phosmet dimethoate chlorpyrifos malathion malathion acephate azinphosmethyl phosalone

[1] All members of Group 1 may not be cross-resistant, although they share the same primary target site and mode of action. For this reason, Group 1 is divided into subgroups Group 1A and 1B, each with different mechanisms of resistance. Assume that cross-resistance exists between pesticides in each sub-group, but that rotation of pesticides between sub-groups is an acceptable part of a resistance management program.

[2] Other resistance mechanisms that are not linked to site of action (i.e. enhanced metabolism) are common for this group of chemicals. All members of this class may not have developed significant cross-resistance.

Table 12-3. Insecticide and Miticide Groups Based on Sites of Action (cont'd)

Group or subgroup	Chemical family or group	Product name	Active ingredient
2A[2]	Chlorinated cyclodiene	Thionex EC Thionex 50 WP	endosulfan endosulfan
3	Pyrethroid	Ambush 500 EC Concept Decis 5 EC Matador 120 EC Perm-Up Pounce 384 EC Ripcord 400 EC Silencer 120 EC Up-Cyde 2.5 EC	permethrin imidaclorpid + deltamethrin* deltamethrin lambda-cyhalothrin permethrin permethrin cypermethrin lambda-cyhalothrin cypermethrin
4	Neonicotinoids	Actara 25 WG Admire 240 F Alias 240 SC Assail 70 WP Calypso 480 SC Concept Clutch 50 WDG	thiamethoxam imidacloprid imidacloprid acetamiprid thiacloprid imidaclorpid* + deltamethrin clothianidin
5	Naturalyte/spinosyns	Delegate WG Entrust 80 W GF-120 NF Success 480 SC	spinetoram spinosad spinosad spinosad
6	Avermectin	Agri-Mek 1.9% EC	abamectin
9C	Pyridine carboxamide	Beleaf 50 SG	flonicamid
10	Tetrazine	Apollo SC	clofentezine
11	B.t. microbial	Bioprotec CAF Dipel 2X DF Foray 48BA	*Bacillus thuringiensis* *Bacillus thuringiensis* *Bacillus thuringiensis*
15	Benzoylureas	Rimon 10 EC	novaluron
18	Ecdysone agonist	Confirm 240 F Intrepid 240 F	tebufenozide methoxyfenozide
20	Acequinocyl	Kanemite 15 SC	acequinocyl
21	Pyridazinone	Nexter	pyridaben
23	Tetronic acid derivatives	Envidor 240 SC Oberon Movento 240 SC	spirodiclofen spiromesefin spirotetramat
25	Carbazate	Acramite 50 WS	bifenazate
28	Anthranilic diamides	Altacor	chlorantraniliprole
NC	Granulosis virus	Virosoft CYD-X	*Cydia pomonella* granulosis virus

[1] All members of Group 1 may not be cross-resistant, although they share the same primary target site and mode of action. For this reason, Group 1 is divided into subgroups Group 1A and 1B, each with different mechanisms of resistance. Assume that cross-resistance exists between pesticides in each sub-group, but that rotation of pesticides between sub-groups is an acceptable part of a resistance management program.

[2] Other resistance mechanisms that are not linked to site of action (i.e. enhanced metabolism) are common for this group of chemicals. All members of this class may not have developed significant cross-resistance.

13. Information on Pesticides

Relative Acute Toxicity of Pesticides

Acute toxicity is the toxic response that results from a single exposure to a pesticide. The symbols and words on the front panel of a pesticide label give you information about the acute toxicity. Table 13-1. *Relative Acute Toxicity of Pesticides and Plant Growth Regulators*, page 262, lists products in this publication according to the relative acute toxicity and warning symbol on the label. This table does not provide information on chronic toxicity, which is the toxic response that results from repeated exposures to small doses of a pesticide over a longer time period. Other warnings about specific hazards such as corrosiveness and skin or eye irritations are not included in this table but can be found on the product label.

Re-entry Interval

The re-entry interval, also referred to as Restricted Entry Interval (REI), is the period of time following a pesticide application during which workers must not enter the treatment area without wearing protective clothing and personal protective equipment. This allows any pesticide residue and vapours to dissipate from the field, preventing the possibility of inadvertent pesticide poisoning.

Health Canada reviews each pesticide to determine whether the label should include a specific re-entry interval. If no re-entry interval is stated on the label for agricultural crops, assume that the REI is 12 hours. Re-entry intervals can vary for different crops and different tasks.

Table 13-2. *Re-entry Intervals for Pesticides and Plant Growth Regulators*, page 263, shows specific minimum intervals between the application of pesticide and working in the treated crop without protective equipment. Use this table as a guide, but refer to the product label for specific information.

Table 13-1. Relative Acute Toxicity of Pesticides and Plant Growth Regulators

Use this table as a guide, but refer to the product label for specific information. Other warnings about specific hazards such as corrosiveness and skin or eye irritations are not included in this table but can be found on the product label.

Danger Symbol on Label Toxicity Level	**Products**		
Danger Poison Symbol* **High Acute Toxicity**	Calypso 480 SC	Guthion 50 WSB	Sniper
	Carzol SP Instapak	Imidan 50 WP	Superior 70 Oil
	Chloropicrin 100	Lime Sulphur	Thionex 50 W
	Decis 5 EC	Lorsban 50 W	Thionex EC
	Diazinon 500 E	Matador 120 EC	Up-Cyde 2.5 EC
	Diazinon 50 WSP	Perm-Up	Vydate L
	Enfuse M 510	Pic Plus Fumigant	Zolone Flo
	Furadan 480 F	Silencer 120 EC	
Warning Poison Symbol* **Moderate Acute Toxicity**	Agri-Mek 1.9% EC	Copper Spray	Manzate 200 WP
	Assail 70 WP	Cygon 480-AG	Mission 418 EC
	Bartlett Waxed Mouse Bait	Dithane DG	Nexter
	Bravo 500	Echo 720	Ramik Brown
	Busan 1020	Guardsman Copper Oxychloride 50	Ridomil Gold 480 SL
	Busan 1180	Lagon 480 E	Sevin XLR
	Busan 1236	Malathion 85 E	Tanos 50 DF
	Copper 53 W	Manzate Pro-Stick	Vapam HL
Caution Poison Symbol* **Low Acute Toxicity**	Admire 240 F	Jade	ReTain
	Alias 240 SC	Lance WDG	Ripcord 400 EC
	Aliette WDG	Malathion 25 W	Rovral
	Allegro 500 F	Microscopic Sulphur	Scala SC
	Ambush 500 EC	Microthiol Disperss	Skoot
	Apollo SC	Nova 40 W	Sovran
	Cantus WDG	Oberon	Syllit 400 FL
	Elevate 50 WDG	Orthene 75% SP	Topas
	Envidor 240 SC	Pounce 384 EC	Vangard 75 WG
	Folpan 80 WDG	Presidio	
No Poison Symbol* **Lower Acute Toxicity**	Acramite 50 WS	Flint 50 WG	Penncozeb 75 DF
	Actara 25 WG	Foray 48BA	Perlan
	Actinovate SP	Fruitone N	Polyram DF
	Altacor	Funginex DC	Pristine WG
	Amid-Thin	Gavel 75 DF	Promalin
	Apogee	GF-120 NF	Purespray Green Spray Oil 13E
	Beleaf 50 SG	Indar 75 WSP	Quintec
	Bioprotec CAF	Inspire	Revus
	Bio-Save 10 LP	Intrepid 240 F	Ridomil Gold MZ 68 WG
	Bloomtime Biological FD	Isomate-CM/OFM TT	Rimon 10 EC
	Cabrio EG	Isomate-GBM Plus	Scholar 230 SC
	Cilis Plus	Isomate-M100	Senator 70 WP
	Clutch 50 WDG	Isomate-M Rosso	Serenade ASO
	Concept	Isomate-P	Serenade MAX
	Confirm 240 F	Kanemite 15 SC	Sluggo Professional
	Cyd-X	Kumulus DF	Streptomycin 17
	Delegate WG	Maestro 80 DF	Success 480 SC
	Dipel 2X DF	Maxcel	Supra Captan 80 WDG
	Entrust 80 W	Mertect SC	Surround WP
	Equal 65 WP	MilStop	Switch 62.5 WG
	Ethrel	Movento 240 SC	Virosoft CP4
	Falgro Tablet	Nustar	Vivando SC
	Ferbam 76 WDG	Opal	

* see label for other important warnings including corrosiveness, skin and eye irritations and chronic toxicity.

Table 13-2. Re-entry Intervals for Pesticides and Plant Growth Regulators

Minimum interval before re-entry	**Product trade name**	**Special comments (see label for details)**
1 hour	Actinovate SP	
4 hours	Bloomtime Biological FD	
	Elevate 50 WDG	
	MilStop	
When dried	Aliette WDG	
	Ambush 500 EC	
	Confirm 240 F	
	Entrust 80 W	• Except 7 days for hand labour on grapes
	Fruitone N	
	Nova 40 W	
	Pounce 384 EC	
	Success 480 SC	• Except 7 days for hand labour on grapes
12 hours For products not listed in this table, and where no re-entry is listed on the label, assume 12 hours.	Acramite 50 WS	• Except 1–5 days for hand labour on grapes, depending on the task (see label)
	Actara 25 WG	
	Agri-Mek 1.9% EC	• Grapes only. 12 hours except 13–21 days for hand labour on grapes
	Altacor	
	Apogee	
	Apollo SC	
	Assail 70 WP	• Except 6 days for hand- thinning of tree fruit • Except 2 days for hand pruning and thinning on blueberries, currants, and other bushberries • Except 5 days for hand labour on grapes
	Beleaf 50 SG	• Except 2 days for hand-thinning tree fruit
	Cabrio EG	• Except 9 days for hand labour on stone fruit (apricots, peaches, cherries, plums) • Except 1 day for hand harvesting blueberries
	Calypso 480 EC	
	Cantus WDG	
	Cilis Plus	
	Clutch 50 WDG	
	Delegate WG	
	Envidor 240 SC	• Except 2 days for some tasks requiring hand labour on grapes (see label)
	Falgro Tablet	
	Flint 50 WG	• Except 4 days for hand- thinning on apples and pears, and 5 days for hand labour on grapes
	Indar 75 WSP	
	Inspire	• Except 4 days for hand- thinning apples and pears and 2 days on grapes (see label for specific tasks)
	Intrepid 240 F	
	Kanemite 15 SC	
	Lance WDG	
	MaxCel	
	Movento 240 SC	
	Nustar	
	Oberon	
	Perlan	
	Perm-Up	

Table 13-2. Re-entry Intervals for Pesticides and Plant Growth Regulators (cont'd)

Minimum interval before re-entry	**Product trade name**	**Special comments (see label for details)**
12 hours (cont'd)	Presidio	• Except 8 days for hand labour (pruning, tying, leaf pulling) on grapes
	Promalin	
For products not listed in this table, and where no re-entry is listed on the label, assume 12 hours.	Purespray Green Spray Oil 13E	
	Quintec	
	ReTain	
	Revus	
	Ridomil Gold 480 SL	
	Rimon 10 EC	
	Rovral	
	Scala SC	• Except 24 hours for hand-thinning on apples and for hand labour (training, tying, leaf pulling) on grapes
	Superior 70 Oil	
	Switch 62.5 WG	• Except 10 days for hand harvest and hand pruning on Saskatoon berries
	Up-Cyde 2.5 EC	
	Vivando SC	• Except for some tasks on grapes, see label for specific exceptions
24 hours	Admire 240 F	
	Alias 240 SC	
	Aliette WDG	• For blueberries only, otherwise when dried
	Allegro 500 F	• Except 3 days for hand-thinning apples
	Concept	
	Folpan 80 WDG	
	Kumulus DF	
	Lorsban 50 W	• Except 4 days for scouting peaches
	Matador 120 EC	
	Microscopic Sulphur	
	Microscopic Wettable Sulphur	
	Microthiol Disperss	
	Nexter	
	Penncozeb 75 DF	
	Pristine WG	• Strawberries, raspberries: 24 hours for hand labour • Blueberries, apricots, cherries, peaches, plums: 24 hours for hand harvest • Longer intervals for hand- thinning and harvest in other crops (see *Greater than 7 days*, page 266). • Otherwise, wait until product is dried
	Ridomil Gold MZ 68 WG	
	Silencer 120 EC	
	Streptomycin 17	• Re-entry is allowed after 24 hours, but not for work that involves contact with plants • Wait 7 days for tasks involving hand labour and 14 days for hand- thinning
	Tanos 50 DF	
	Vydate L	• Non-bearing apples: 1 day • Raspberries: 3 days

Table 13-2. Re-entry Intervals for Pesticides and Plant Growth Regulators (cont'd)

Minimum interval before re-entry	Product trade name	Special comments (see label for details)
48 hours	Bravo 500	
	Copper 53 W	
	Copper Spray	
	Echo 720	
	Equal 65 WP	
	Ethrel	
	Funginex DC	
	Furadan 480 F	
	Gavel 75 DF	
	Guardsman Copper Oxychloride 50	
	Lime Sulphur	
	Maestro 80 DF	• Tree fruit and strawberries: 48 hours • Grapes, raspberries and blueberries: 72 hours
	Sovran	
	Supra Captan 80 WDG	• Tree fruit and strawberries: 48 hours • Grapes, raspberries and blueberries: 72 hours
	Syllit 400 FI	
	Thionex 50 W	• Grapes: 48 hours • Tree fruit: 4 days • Strawberries: 5 days (based on PMRA re-evaluation Rev 2011-01)
	Vangard 75 WG	• Grapes: 48 hours • Apples, apricots, peaches, plums: 72 hours
72 hours	Jade	
	Maestro 80 DF	• Tree fruit and strawberries: 48 hours • Grapes, raspberries and blueberries: 72 hours
	Mission 418 EC	
	Orthene 75% SP	• For Saskatoon berries only; different for other crops on label
	ReTain	
	Supra Captan 80 WDG	• Tree fruit and strawberries: 48 hours • Grapes, raspberries and blueberries: 72 hours
	Topas	
	Vangard 75 WG	• Grapes: 48 hours • Apples, apricots, peaches, plums: 72 hours
	Vydate L	• Non-bearing apples: 1 day • Raspberries: 3 days

Table 13-2. Re-entry Intervals for Pesticides and Plant Growth Regulators (cont'd)

Minimum interval before re-entry	Product trade name	Special comments (see label for details)
Greater than 3 days	Carzol SP Instapak	• For apples, pears, peaches, nectarines: • 12 days for weeding, irrigating, scouting • 14 days for harvesting propping, training, pruning • 19 days for hand-thinning
	Chloropicrin 100	• A full-face respirator is required for entry into treated areas within 14 days of application
	Diazinon 500 E	• Apples and apricot, cherry, peach, plum and prune: 4 days • Pears: 5 days • Raspberry, blackberry, gooseberry, currant: 6 days
	Diazinon 50 WSP	• Apples and apricot, cherry, peach, plum and prune: 4 days • Pears: 5 days • Raspberry, blackberry, gooseberry, currant: 6 days
	Entrust 80 W	• Grapes: 7 days for hand labour, otherwise when dry
	Guthion 50 WSB	• Raspberries: 7 days • Tree fruits: 14 days except 15 days for cherries • Grapes: 28 days • Non-agricultural workers (i.e. pick-your own customers): 30 days
	Imidan 50 WP	• Tree fruit: 14 days for non-agricultural workers (i.e. pick-your-own customers) otherwise, 7 days for apples, pears, peaches, plums, and 3 days for cherries • Blueberries: 15 days for non-agricultural workers (i.e. pick-your-own customers) otherwise 3 days • Grapes: 14 days
	Thionex EC	• Strawberries: 4 days for scouting, hand weeding, irrigation, mulching, 7 days for all other activities
	Thionex 50 W	• Apricot, peach, cherry, plum: 7 days, except 20 days for hand- thinning • Pears: 4 days for all activities • Strawberries: 7 days for scouting, hand weeding, irrigation, mulching, 12 days for all other activities
	Streptomycin 17	• 7 days for scouting and contact activities • 14 days for hand-thinning
	Success 480 SC	• Grapes: 7 days for hand labour, otherwise when dry
	Surround WP	• A nuisance-dust mask is recommended for workers re-entering fields to conduct activities that involve contact with foliage
	Pic Plus Fumigant	• A full-face respirator is required for entry into treated areas within 14 days of application
	Pristine WG	• Berry crops: • 29 days for hand harvest in currant and gooseberries, Saskatoon berries • 24 hours for hand harvest of strawberries, blueberries • 24 hours for hand harvest and hand labour in raspberries • Grapes: 21 days for hand labour • Apples and pears: 5 days for hand harvest, 12 days for hand- thinning • Stone fruit (apricots, cherries, peaches, plums): 24 hours for hand harvest and hand pruning of stone fruit, 10 days for hand-thinning stone fruit • Otherwise wait until product is dried
	Sniper	• See Guthion 50 WSB, above
	Zolone Flo	• 14 days for farm workers, and 30 days for non-agricultural workers (i.e. pick-your-own customers)

Bee Poisoning

Honey bees, native bee species and other pollinating insects are important pollinators for many Ontario crops. Insecticides, some of which may negatively affect bees, are required for insect control. With careful management, both pollination and insect control can be achieved. Growers and licensed commercial exterminators can protect bees by following these suggestions:

- Before applying a pesticide, advise local beekeepers so they can move colonies out of the danger area. Contact the Provincial Apiarist at 1-888-466-2372 ext. 63595 for a list of the beekeepers in the area or see *www.ontario.ca/crops* and click "Apiculture" for a list of provincial bee inspectors who know the local beekeepers.

- Do not apply insecticides while fruit trees are in bloom. The *Bees Act* makes it an offence to do so in Ontario. Do not spray any flowering crop on which bees are foraging and read the pesticide label for guidelines.

- Time insecticide applications to minimize bee poisoning. Daytime treatments, when bees are foraging, are most hazardous. Insecticide applications in the evening are the safest. Spraying after 8 PM allows the spray to dry before the bees are exposed to it the next day. This is the most successful way to avoid bee damage. Early morning is the next best time, but spraying should be completed before 7 AM. While honeybees and most other pollinating insects do not usually forage at temperatures below 13°C, bumblebees do. If you plan to spray in the morning, contact beekeepers who have bees within 10 km of your crop. The beekeepers will then have the option of taking protective action.

- Beekeepers can place wet bags in the entrance of the hive to disrupt the flight of the bees for up to 12 hours and provide more time for spray to dry. An opening of 2.5 cm (1 inch) on each side of the hive entrance is necessary so the bees can get out and ventilate the hive.

- Beekeepers should remove honeybee colonies as soon as pollination is complete and before any postbloom insecticides are applied.

- Honeybees may be poisoned by visiting weeds or cover crops, such as dandelions or clovers that are in bloom in the orchard or field. Avoid spray drift to blooming plants that are adjacent to the target field. Where possible, mow down such crops prior to a spray to help safeguard the bees.

- Do not apply insecticide on windy days to prevent drift toward any nearby hives.

- If there is a risk of honeybee poisoning, try to choose an insecticide that is not highly toxic to the bees from the list in Table 13-3. *Relative Toxicity of Pesticides to Honeybees,* page 268. When there is a choice, choose a product formulation that is less hazardous to bees. EC formulations are usually less toxic than WP formulations.

Table 13-3. *Relative Toxicity of Pesticides to Honeybees,* page 268, shows the relative toxicity of products used on fruit crops to honeybees as determined by laboratory and field tests.

For more detailed information on the toxicity of specific pesticides to honeybees refer to the pesticide label.

Table 13-3. Relative Toxicity of Pesticides to Honeybees

Group I: Pesticides highly toxic to bees

Severe losses may be expected if the following materials are used when bees are present at treatment time or within a few days thereafter.

Actara 25 WG	thiamethoxam
Admire 240 F	imidacloprid
Agri-Mek 1.9% EC	abamectin
Alias 240 SC	imidacloprid
Ambush 500 EC	permethrin
Clutch 50 WDG	clothianidin
Concept	imidacloprid + deltamethrin
Cygon 480-AG	dimethoate
Decis 5 EC	deltamethrin
Delegate WG	spinetoram
Diazinon 500 E	diazinon
Diazinon 50 WSP	diazinon
Entrust 80 W	spinosad
Furadan 480 F	carbofuran
GF-120 NF	spinosad
Guthion 50 WSB	azinphosmethyl
Imidan 50 WP	phosmet
Lagon 480 E	dimethoate
Lorsban 50 W	chlorpyrifos
Malathion 25 W	malathion
Malathion 85 E	malathion
Matador 120 EC	lambda-cyhalothrin
Movento 240 SC	spirotetramat
Nexter	pyridaben
Orthene 75% SP	acephate
Perm-Up	permethrin
Pounce 384 EC	permethrin
Ripcord 400 EC	cypermethrin
Sevin XLR	carbaryl
Silencer 120 EC	lambda-cyhalothrin
Success 480 SC	spinosad
Sniper	azinphosmethyl
Up-Cyde 2.5 EC	cypermethrin
Vydate L	oxamyl

Group II: Pesticides moderately toxic to bees

These can be used around bees if dosage, timing, and method of application are correct, but do not apply them directly on bees, in the field or at the colonies.

Acramite 50 WS	bifenazate
Assail 70 WP	acetamiprid
Carzol SP Instapak	formetanate hydrochloride
Copper 53 W	tri-basic copper sulphate
Envidor 240 SC	spirodiclofen
Maestro 80 DF	captan
Movento 240 SC	spirotetramat
Nustar	flusilazole
Quintec	quinoxyfen
Rimon 10 EC*	novaluron
Supra Captan 80 WDG	captan
Thionex EC	endosulfan
Thionex 50 W	endosulfan
Zolone Flo	phosalone

Group III: Pesticides relatively non-toxic to bees

Actinovate SP	*Stretomyces lydicus*
Aliette WDG	fosetyl al
Allegro 500 F	fluazinam
Altacor	chlorantraniliprole
Apogee	prohexadione calcium
Apollo SC	clofentezine
Beleaf 50 SG	flonicamid
Bioprotec CAF	*Bacillus thuringiensis* var. *kurstaki*
Bloomtime Biological FD	*Pantoea agglomerans*
Bravo 500	chlorothalonil
Cabrio EG	pyraclostrobin
Calypso 480 SC	thiacloprid
Cantus WDG	boscalid
Confirm 240 F	tebufenozide
Copper Spray	copper from copper oxychloride
Cyd-X	granulosis virus
Dipel 2X DF	*Bacillus thuringiensis* var. *kurstaki*
Dithane DG	mancozeb
Echo 720	chlorothalonil
Elevate 50 WDG	fenhexamid
Equal 65 WP	dodine
Ferbam 76 WDG	ferbam
Flint 50 WG	trifloxystrobin
Folpan 80 WDG	folpet
Foray 48BA	*Bacillus thuringiensis* var. *kurstaki*
Funginex DC	triforine
Gavel 75 DF	zoxamide/mancozeb
Indar 75 WSP	fenbuconazole
Inspire	difenoconazole
Intrepid 240 F	methoxyfenozide
Jade	propiconazole
Kanemite 15 SC	acequinocyl
Kumulus DF	sulphur
Lance WDG	boscalid
Manzate 200 WP	mancozeb
Manzate Pro-Stick	mancozeb
MaxCel	6-benzyladenine
Microthiol Disperss	sulphur
MilStop	potassium bicarbonate
Mission 418 E	propiconazole
Nova 40 W	myclobutanil
Oberon	spiromesefin
Opal	potassium salts of fatty acids
Penncozeb 75 DF	mancozeb
Polyram DF	metiram
Presidio	fluopicolide
Pristine WG	boscalid + pyraclostrobin
Revus	mandipropamid
Ridomil Gold 480 SL	metalaxyl-m
Ridomil Gold MZ 68 WG	metalaxyl + mancozeb
Rovral	iprodione
Scala SC	pyrimethanil
Scholar 230 SC	fludioxonil
Senator 70 WP	thiophanate-methyl
Serenade MAX	*Bacillus subtilis*
Serenade ASO	*Bacillus subtilis*
Sovran	kresoxim-methyl
Switch 62.5 WG	cyprodinil + fludioxonil
Syllit 400 FL	dodine
Tanos 50 DF	famoxadone + cymoxanil
Topas	propiconazole
Vangard 75 WG	cyprodinil
Virosoft CP4	*Cydia pomonella* granulovirus
Vivando	metrafenone

* Rimon may be toxic to bee colonies exposed to direct treatment, drift or residues on flowering crops or weeds. Avoid spraying if bees are visiting the treatment area.

Source: PMRA Environmental Assessment Division. For more detailed information on the toxicity of specific pesticides to honeybees refer to the pesticide label.

Use of Copper Products on Fruit Crops

Chemical characteristics of copper fungicides

Copper mixtures have long been recognized as having fungicidal and bactericidal properties. Historically, Bordeaux mixture was an important copper fungicide. It was made by mixing bluestone, which is a raw form of copper sulphate and hydrated lime.

Free copper ions provide most of the activity copper mixtures have on fungal and bacterial diseases. However, free copper can also be toxic to plants, as it can cause burned leaves and russeted or scarred fruit. Bordeaux mixtures are considered unsafe after "¼ inch green" on most fruit crops.

Fixed copper collectively describes a group of copper formulations that contain complex copper sulphates, copper oxychlorides, and copper oxides.

Fixed copper compounds are:

- easier to handle than Bordeaux
- equal in efficacy to Bordeaux, except they do not adhere or persist as well
- generally less phytotoxic and less corrosive than Bordeaux

These new copper formulations have a small particle size and have added materials to improve spreading and sticking qualities. Always check the product label for use patterns, rates and timings for each crop.

Procedures to tank-mix copper formulations and lime

Some fixed copper labels suggest mixing the copper with lime. If problems occur while mixing fixed coppers with lime, follow these instructions:

1. Start water flow into the spray tank.
2. When the tank is about one-third full and the mechanical agitator is on, wash the powdered copper product into the tank through a screen with water from the supply hose. Use a wooden spoon to help work the copper product through the screen. The screen prevents large granules of copper, which form if opened product gets wet then dries, from getting into the tank. Premix the copper product with hot water to help the product dissolve. Put all of the copper in the tank by the time the tank is two-thirds full.
3. Wash the lime mixture through the screen into the copper solution in the tank. Use hydrated or builder's lime. Pre-soaking the lime before you add it to the copper solution in the tank may be preferable to washing powdered lime directly through the screen into the tank. Use a lot of water from the supply hose to dilute the lime as much as possible before it meets the copper solution.
4. Keep the agitator running continuously and apply the copper mixture immediately. Do not allow the mixture to settle out.

Registration status and availability of copper fungicide products

It is important to use only copper products approved as crop protection products for application on agricultural crops that have a federal label with a Pest Control Product (PCP) number. For a summary of available labelled products and crop uses, consult Table 13-4. *Copper Products Available for Use on Fruit Crops in Ontario*, page 270.

Table 13-4. Copper Products Available for Use on Fruit Crops in Ontario

Category	**Registered Copper Products**		
Product Name	Copper 53 W	Guardsman Copper Oxychloride 50	Copper Spray
PCP Registration No.	19934	13245	19146
Active Ingredient	copper from basic copper sulfate 53.4%	copper from copper oxychloride 50%	copper from copper oxychloride 50%
APPLES			
registration status	✓	✗	✓
rate of formulated copper[1]	1 kg		4 kg
rate of hydrated lime	6 kg		no lime required
BLUEBERRIES (highbush)			
registration status	✗	✓	✓
rate of formulated copper[1]		2–4 kg[2]	2–4 kg[2]
rate of hydrated lime		no lime required	no lime required
CRANBERRIES			
registration status	✗	✓	✓
rate of formulated copper[1]		2–4 kg[2]	4 kg[2]
rate of hydrated lime		no lime required	no lime required
CURRANTS			
registration status	✓	✗	✗
rate of formulated copper[1]	3–5 kg		
rate of hydrated lime	4 kg		
FILBERTS HAZELNUTS			
registration status	✗	✓	✓
rate of formulated copper		3–9 kg/ha	3–9 kg/ha
rate of hydrated lime		no lime required	no lime required
GOOSEBERRIES			
registration status	✓	✗	✗
rate of formulated copper[1]	3–5 kg		
rate of hydrated lime	4 kg		
GRAPES			
registration status	✓	✓	✓
rate of formulated copper[1]	3 kg[3]	3 kg[4]	3 kg[4]
rate of hydrated lime	6 kg	6 kg	6 kg
NECTARINE			
registration status	✓	✗	✗
rate of formulated copper[1]	4 kg		
rate of hydrated lime	no lime required		
PEACHES			
registration status	✓	✓	✓
rate of formulated copper[1]	1.9 kg	2 kg	2 kg
rate of hydrated lime	no lime required	no lime required	no lime required
PEARS			
registration status	✓	✗	✗
rate of formulated copper[1]	1 kg		
rate of hydrated lime	6 kg		
RASPBERRIES			
registration status	✓	✓	✓
rate of formulated copper	4–5 kg/ha	2.5–3.0 kg/ha	2.5–3.0 kg/ha
rate of hydrated lime	no lime required	no lime required	no lime required

[1] Rate is expressed kg/1,000 L of water unless otherwise stated. Also check label for maximum rate/ha.

[2] Rate is expressed in kg/500–1,000 L of water/ha.

[3] Do not use on French hybrids or vinifera varieties.

[4] Do not use on Seibel varieties.

[5] Use 2 kg/ha with 4 kg/ha of hydrated lime for brown rot and leaf spot control. Use 6–9 kg/ha without lime for bacterial canker control.

✓ Registered for Ontario.

✗ Not registered for Ontario.

Table 13-4. Copper Products Available for Use on Fruit Crops in Ontario (cont'd)

Category	Registered Copper Products		
Product Name	Copper 53 W	Guardsman Copper Oxychloride 50	Copper Spray
PCP Registration No.	19934	13245	19146
Active ingredient	copper from basic copper sulfate 53.4%	copper from copper oxychloride 50%	copper from copper oxychloride 50%
SOUR CHERRIES			
registration status	✓	✓	✓
rate of formulated copper[1]	2 kg	2 kg[5]	2 kg[5]
rate of hydrated lime	4 kg	4 kg	4 kg
SWEET CHERRIES			
registration status	✗	✓	✓
rate of formulated copper		6–9 kg/ha	6–9 kg/ha
rate of hydrated lime		no lime required	no lime required
STRAWBERRIES			
registration status	✓	✗	✗
rate of formulated copper	2.5–3.8 kg/ha		
rate of hydrated lime	no lime required		
WALNUTS			
registration status	✗	✗	✓
rate of formulated copper			4 kg/ha
rate of hydrated lime			no lime required

[1] Rate is expressed kg/1,000 L of water unless otherwise stated. Also check label for maximum rate/ha.

[2] Rate is expressed in kg/500–1,000 L of water/ha.

[3] Do not use on French hybrids or vinifera varieties.

[4] Do not use on Seibel varieties.

[5] Use 2 kg/ha with 4 kg/ha of hydrated lime for brown rot and leaf spot control. Use 6–9 kg/ha without lime for bacterial canker control.

✓ Registered for Ontario.

✗ Not registered for Ontario.

Pesticides Used on Fruit Crops in Ontario

See Table 13-5. *Pesticides Used On Fruit Crops in Ontario*, on this page for information on pesticides used on fruit crops in Ontario and Table 13-6. *Thinners and Plant Growth Regulators Used on Fruit Crops in Ontario*, page 284, for information on thinners and growth regulators used on fruit crops in Ontario.

Table 13-5. Pesticides Used on Fruit Crops in Ontario

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
	abamectin	see AGRI-MEK 1.9% EC						
	acephate	see ORTHENE 75% SP						
	acequinocyl	see KANEMITE 15 SC						
	acetamiprid	see ASSAIL 70 WP						
27925	ACRAMITE 50 WS	bifenazate	a	apples, filberts/ hazelnuts, grapes, pecans, raspberries, sweet chestnuts, walnuts	WSP	50 %	4	CRE
28408	ACTARA 25 WG	thiamethoxam	i	apples, elderberries, pears, sea buckthorn	WDG	25%	3	SYZ
28672	ACTINOVATE SP	*Streptomyces lydicus* strain WYEC108	f	strawberries	WP	0.037%	4	NIJ, PLG
24094	ADMIRE 240 F	imidacloprid	i	apples, blueberries, cherries, peaches, raspberries, Saskatoon berries, strawberries	FL	240 g/L	4	BCZ
24551	AGRI-MEK 1.9% EC	abamectin	a,i	apples, grapes, pears, raspberries, strawberries	EC	19 g/L	3	SYZ
28475	ALIAS 240 SC	imidacloprid	i	apples, blueberries	SC	240 g/L	4	MKC
24458	ALIETTE WDG	fosetyl al	f	apples, blueberries, raspberries, strawberries	WG	80%	3	BCZ
27517	ALLEGRO 500 F	fluazinam	f	apples, blueberries, elderberries	FL	40%	3	SYZ, ISK
28981	ALTACOR	chlorantraniliprole	i	pome fruit group, stone fruit group, filberts/ hazelnuts, grapes, pecans, raspberries, sweet chestnuts, walnuts	WG	35%	2	DUQ
14882	AMBUSH 500 EC	permethrin	i	apples, peaches, pears, grapes	EC	500 g/L	4	AMV
28042	APOGEE	prohexadione calcium	pgr	apples	WG	27.5%	4	BAZ

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[1] a – acaracide, miticide; b – bactericide; ba - bacterial antagonist; f – fungicide ; h – herbicide; i – insecticide; n – nematicide; r – rodenticide; md – mating disrupter; pgr – plant growth regulator; s – slug bait; tr – taste repellent.

[2] Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; FDP – fast dissolving powder; FL – flowable; GR – granule; L – liquid; P – particulate; SC – suspension concentrate; SG – soluble granules; SN – solution; SU – suspension (flowable); WDG – water dispersible granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

[3] See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Table 13-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
21035	APOLLO SC	clofentezine	a	apples, peaches, raspberries, strawberries	SC	500 g/L	3	MKC
27128	ASSAIL 70 WP	acetamiprid	i	pome fruit group, stone fruit group, blueberries, currants, elderberries, grapes, Saskatoon berries, sea buckthorn, strawberries	WP	70%	4	DUQ, NSC
	azinphosmethyl	**see GUTHION 50 WSB, SNIPER**						
	Bacillus subtilis	**see SERENADE MAX, SERENADE ASO**						
	Bacillus thuringiensis* var. *kurstaki	**see DIPEL 2X DF, FORAY 48BA, BIOPROTEC CAF**						
8024	BARTLETT WAXED MOUSE BAIT	zinc phosphide	r	orchards	P	2%	3	BAT
29796	BELEAF 50 SG	flonicamid	i	apples, sour cherries peach, plum	WG	50%	4	UAG, ISK,
	bifenazate	**see ACRAMITE 50 WS**						
26854	BIOPROTEC CAF	*Bacillus thuringiensis var. kurstaki*	i	apples, apricots, blueberries, cherries, pears, raspberries, sea buckthorn	SU	12.7 BIU/L	3	AFG
29673	BIO-SAVE 10 LP	*Pseudomonas syringae strain ESC-10*	f	apples, cherries, pears	WP	29.8%	4	JET
28436	BLOOMTIME BIOLOGICAL FD	*Pantoea agglomerans strain E325*	ba	apples, pears, Saskatoon berries, raspberries	FDP	1 x 10 ^{10} CFU/g	4	NAP
	boscalid	**see CANTUS WDG, LANCE WDG**						
	boscalid + pyraclostrobin	**see PRISTINE WG**						
15723	BRAVO 500	chlorothalonil	f	blueberries, cherries, peaches, strawberries	SC	500 g/L	4	SYZ
19421	BUSAN 1020	metam sodium	n,f,h	fruit crops (before planting)	L	33%	4	BUL
25124	BUSAN 1180	metam potassium	n,f,h	fruit crops (before planting)	L	54%	3	BUL
25103	BUSAN 1236	metam sodium	n,f,h	fruit crops (before planting)	L	42.5%	4	BUL
27323	CABRIO EG	pyraclostrobin	f	blueberries, cherries, strawberries	WG	20%	4	BAZ, ENG
	calcium polysulphide	**see LIME SULPHUR**						
28429	CALYPSO 480 SC	thiacloprid	i	apples, pears	SC	480g/L	3	BCZ

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[2] Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; FDP – fast dissolving powder; FL – flowable; GR – granule; L – liquid; P – particulate; SC – suspension concentrate; SG – soluble granules; SN – solution; SU – suspension (flowable); WDG – water dispersible granule; WG – wettable granular; WP – wettable powder; WSP – water solubile packets.

[3] See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Table 13-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
30141	CANTUS WDG	boscalid	f	stone fruit group, blueberries, currants, elderberries, grapes, raspberries, strawberries	WDG	70%	2	BAZ
	captan	**see SUPRA CAPTAN 80 WDG, MAESTRO 80 DF**						
	carbaryl	**see SEVIN XLR**						
	carbofuran	**see FURADAN 480 F**						
29991	CARZOL SP INSTAPAK	formetanate hydrochloride	a,i	apples, peaches, pears	WSP	92%	2	GOW
	chlorantraniliprole	**see ALTACOR**						
	chloropicrin	**see CHLOROPICRIN 100, PIC PLUS FUMIGANT**						
25863	CHLOROPICRIN 100	chloropicrin	f,n	raspberries, strawberries (before planting)	L	99%	2	HND, DAS
	chlorothalonil	**see BRAVO 500, ECHO 720**						
	chlorpyrifos	**see LORSBAN 50 W**						
	clofentezine	**see APOLLO SC**						
	clothianidin	**See CLUTCH 50 WDG**						
29382	CLUTCH 50 WDG	clothianidin	i	pome fruit group, stone fruit group, grapes	WDG	50%	2	VAJ
29611	CONCEPT	imidacloprid + deltamethrin	i	blueberries	SC	75 g/L + 10 g/L	3	BCZ
24503	CONFIRM 240 F	tebufenozide	i	apples	FL	240 g/L	3	GOW, NSC
9934	COPPER 53 W	tri-basic copper sulphate	b, f	apples, currants, strawberries	WP	53%	3	UAG, LOI
19146	COPPER SPRAY	copper from copper oxychloride	f	cherries, filberts/ hazelnuts, grapes, peaches, walnuts	WP	50%	4	UAG, LOI
	copper from copper oxychloride	**see COPPER SPRAY, GUARDSMAN COPPER OXYCHLORIDE 50**						
	***Cydia pomonella* granulovirus**	**see CYD-X, VIROSOFT CP4**						
30120	CYD-X	*Cydia pomonella* granulovirus	i	apples	SU	0.06%	3	CRU, ENG
25651	CYGON 480-AG	dimethoate	i	blueberries, filberts/ hazelnuts, strawberries	EC	480 g/L	3	CAU
	cymoxanil + famoxadone	**see TANOS 50 DF**						
	cypermethrin	**see RIPCORD 400 EC, UP-CYDE 2.5 EC**						
	cyprodinil	**see VANGARD 75 WG**						

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[2] Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; FDP – fast dissolving powder; FL – flowable; GR – granule; L – liquid; P – particulate; SC – suspension concentrate; SG – soluble granules; SN – solution; SU – suspension (flowable); WDG – water dispersible granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

[3] See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Table 13-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
	cyprodinil + fludioxonil	**see SWITCH 62.5 WG**						
22478	DECIS 5 EC	deltamethrin	i	apples, blueberries, peaches, pears, strawberries	EC	50 g/L	3	BCZ
28778	DELEGATE WG	spinetoram	i	pome fruit group, stone fruit group, blueberries, grapes, raspberries, strawberries	WG	25%	3	DWE
	deltamethrin	**see DECIS 5 EC**						
	deltamethrin + imidaclorpid	**see CONCEPT**						
	diazinon	**see DIAZINON 50 WSP, DIAZINON 500 E**						
11889	DIAZINON 500 E	diazinon	i	apples, currants, raspberries	EC	500 g/L	3	UAG, LOI
29976	DIAZINON 50 WSP	diazinon	i	apples, cherries, currants, plums, raspberries	WSP	50%	3	UAG, LOI
	difenoconazole	**see INSPIRE**						
	dimethoate	**see CYGON 480-AG, LAGON 480 E**						
26508	DIPEL 2X DF	*Bacillus thuringiensis* var. *kurstaki*	i	apples, apricots, blueberries, cherries, currants, elderberries, filberts/hazelnuts, grapes, pecans, pears, raspberries, Saskatoon berries, sea buckthorn, strawberries, sweet chestnuts, walnuts	DF	57%	4	VAJ, VBC
	diphacinone	**see RAMIK BROWN**						
29221	DITHANE DG	mancozeb	f	apples	DG	75%	4	DWE
	dodine	**see EQUAL 65 WP, SYLLIT 400 FL**						
29355	ECHO 720	chlorothalonil	f	blueberries, peaches, sour cherries, strawberries	FL	720 g/L	4	UAG
25900	ELEVATE 50 WDG	fenhexamid	f	blueberries, cherries, currants, elderberries, grapes, peaches, raspberries, strawberries	WDG	50%	3	TOA
	endosulfan	**see THIONEX EC, THIONEX 50 W**						
29142	ENFUSE M 510	metam sodium	f,n,h	fruit crops (before planting)	L	42%	4	ENG

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[2] Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; FDP – fast dissolving powder; FL – flowable; GR – granule; L – liquid; P – particulate; SC – suspension concentrate; SG – soluble granules; SN – solution; SU – suspension (flowable); WDG – water dispersible granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

[3] See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Table 13-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
27825	ENTRUST 80 W	spinosad	i	pome fruit group, apricots, blueberries, cherries, currants, elderberries, grapes, plums, raspberries, Saskatoon berries, sea buckthorn, strawberries	WG	80%	3	DWE
28051	ENVIDOR 240 SC	spirodiclofen	a	pome fruit group, apricots, grapes, peaches, sour cherries	SC	240 g/L	4	BCZ
15608	EQUAL 65 WP	dodine	f	cherries, pears	WP	65%	4	NOC
	famoxadone + cymoxanil	see TANOS 50 DF						
	fenbuconazole	see INDAR WSP						
	fenhexamid	see ELEVATE 50 WDG						
	ferbam	see FERBAM 76 WDG						
20136	FERBAM 76 WDG	ferbam	f	apples, blueberries, currants, grapes, peaches, raspberries, sour cherries	WDG	76%	4	UAG, LOI
	ferric phosphate	see SLUGGO PROFESSIONAL						
27529	FLINT 50 WG	trifloxystrobin	f	pome fruit group, cherries, filberts/ hazelnuts, grapes	WDG	50%	3	BCZ
	flonicamid	see BELEAF 50 SG						
	fluazinam	see ALLEGRO 500 F						
	fludioxonil	see SCHOLAR 230 SC						
	fludioxonil + cyprodinil	see SWITCH 62.5 WG						
	fluopicolide	see PRESIDIO						
	flusilazole	see NUSTAR						
27733	FOLPAN 80 WDG	folpet	f	grapes, strawberries	WDG	80%	4	MKC
	folpet	see FOLPAN 80 WDG						
24978	FORAY 48BA	*Bacillus thuringiensis* var. *kurstaki*	i	apples, blueberries, pears, raspberries	L	10 BIU/ kg	4	VBC
	formetanate hydrochloride	see CARZOL SP INSTAPAK						
	fosetyl al	see ALIETTE WDG						
27686	FUNGINEX DC	triforine	f	blueberries, cherries, peaches, plums, Saskatoon berries	EC	190 g/L	3	ENG
10828	FURADAN 480 F	carbofuran	i	strawberries	FL	480 g/L	2	BCZ

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[3] See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Table 13-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
26842	GAVEL 75 DF	zoxamide + mancozeb	f	grapes	DF	8.4% + 66.7%	4	GOW
28336	GF-120 NF	spinosad	i	apples, blueberries, cherries, walnuts	L	0.02%	4	DWE
13245	GUARDSMAN COPPER OXYCHLORIDE 50	copper from copper oxychloride	f	cherries, filberts, grapes, peaches, hazelnuts	WP	50%	3	VAR
21374	GUTHION 50 WSB	azinphosmethyl	i	raspberries	WSP	50%	2	MKC
	imidacloprid	**see ADMIRE 240 F, ALIAS 240 SC**						
	imidacloprid + deltamethrin	**see CONCEPT**						
23006	IMIDAN 50 WP	phosmet	i	apples, blueberries, grapes, sour cherries, pears, plums	WSP	50%	4	GOW
27294	INDAR 75 WSP	fenbuconazole	f	apricots, cherries, peaches, plums	WSP	75%	2	DWE
30004	INSPIRE	difenoconazole	f	apples, pears, grapes	EC	250 g/L	3	SYN
27786	INTREPID 240 F	methoxyfenozide	i	apples, pears, peaches	FL	240 g/L	3	DWE
	iprodione	**see ROVRAL**						
29352	ISOMATE-CM/OFM TT	pheromone, oriental fruit moth and codling moth	md	apples, pears, walnuts	DIS	92%	4	PBC
27525	ISOMATE-GBM PLUS	pheromone, grape berry moth	md	grapes	DIS	91.1%	4	PBC
26981	ISOMATE-M100	pheromone, oriental fruit moth	md	apples, apricots, peaches, pears	DIS	95.2%	4	PBC
27339	ISOMATE-M ROSSO	pheromone, oriental fruit moth	md	apples, apricots, peaches, pears	DIS	95.2%	4	PBC
27141	ISOMATE-P	pheromone, peachtree borer	md	peaches, plums	DIS	83.7%	4	PBC
24030	JADE	propiconazole	f	apricots, blueberries, cherries, peaches, plums, Saskatoon berries, strawberries	EC	250 g/L	3	ENG
28641	KANEMITE 15 SC	acequinocyl	a	apples, pears	SC	15.8%	3	TOA
	kaolin	**see SURROUND WP**						
	kresoxim-methyl	**see SOVRAN**						

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Table 13-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
18836	KUMULUS DF	sulphur	a,f	apples, grapes, pears, peaches, Saskatoon berries, sour cherries	WDG	80%	4	BAZ, ENG
9382	LAGON 480 E	dimethoate	i	blueberries, filberts/ hazelnuts	EC	480 g/L	3	UAG, LOI
	lambda-cyhalothrin	see SILENCER 120 EC, MATADOR 120 EC						
27495	LANCE WDG	boscalid	f	apricots, blueberries, cherries, currants, elderberries, grapes, peaches, plums, raspberries, strawberries	WG	70%	2	BAZ
16465	LIME SULPHUR	calcium polysulphide	i,f	blueberries, raspberries	L	30%	4	UAG, LOI
20944	LORSBAN 50 W	chlorpyrifos	i	peaches	WP	50%	3	DWE
26408	MAESTRO 80 DF	captan	f	apples, apricots, blueberries, cherries, grapes, peaches, pears, plums, raspberries, strawberries	DF	80%	3	TOA
	malathion	see MALATHION 25 W, MALATHION 85 E						
14656	MALATHION 25 W	malathion	i	apples, blueberries, currants, raspberries, strawberries	WP	25%	4	UAG, LOI
8372	MALATHION 85 E	malathion	i	apples, grapes	EC	85%	3	UAG, LOI
	mancozeb	see MANZATE PRO-STICK, MANZATE 200 WP, DITHANE DG, PENNCOZEB 75 DF						
	mancozeb + metalaxyl	see RIDOMIL GOLD MZ 68 WG						
	mancozeb + zoxamide	see GAVEL 75 DF						
	mandipropamid	see REVUS						
10526	MANZATE 200 WP	mancozeb	f	grapes	WP	80%	4	UPI
28217	MANZATE PRO-STICK	mancozeb	f	apples	DF	75%	3	UPI
24984	MATADOR 120 EC	lambda-cyhalothrin	i	apples, peaches, pears, strawberries	EC	120 g/L	2	SYZ
13975	MERTECT SC	thiabendazole	f	apples, pears	SU	500 g/L	4	SYZ
	metalaxyl + mancozeb	see RIDOMIL GOLD MZ 68 WG						
	metalaxyl-m and s-isomers	see RIDOMIL GOLD 480 SL						
	metam potassium	see BUSAN 1180						
	metam sodium	see VAPAM HL, BUSAN 1020, BUSAN 1236, ENFUSE M510						
	methoxyfenozide	see INTREPID 240 F						
	metiram	see POLYRAM DF						

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[2] Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; FDP – fast dissolving powder; FL – flowable; GR – granule; L – liquid; P – particulate; SC – suspension concentrate; SG – soluble granules; SN – solution; SU – suspension (flowable); WDG – water dispersible granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

[3] See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Table 13-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
	metrafenone	see VIVANDO SC						
14653	MICROSCOPIC SULPHUR	sulphur	f	apples, currants, grapes, peaches, plums, sea buckthorn	WP	92%	4	UAG, LOI
873	MICROSCOPIC WETTABLE SULPHUR	sulphur	f	apples, currants, grapes, peaches, plums	WP	92%	4	BAT
29487	MICROTHIOL DISPERSS	sulphur	f	apples, grapes, peaches, pears, plums, Saskatoon berries, sour cherries	WDG	80%	4	UPI
28095	MILSTOP	potassium bicarbonate	f	grapes	WP	85%	4	BWI
	mineral oil	see PURESPRAY GREEN SPRAY OIL 13E, SUPERIOR 70 OIL						
28016	MISSION 418 EC	propiconazole	f	stone fruit group, blueberries, Saskatoon berries, strawberries	EC	418 g/L	3	MKC
28953	MOVENTO 240 SC	spirotetramat	i	pome fruit group, cherries, filberts/ hazelnuts, grapes, peaches, plums, pecans, sweet chestnuts, walnuts	SC	240 g/L	4	BCZ
	myclobutanil	see NOVA 40 W						
25135	NEXTER	pyridaben	a,i	apples, grapes, pears, peaches, raspberries, sour cherries, strawberries	WSP	75%	3	GOW
22399	NOVA 40 W	myclobutanil	f	apples, cherries, grapes, peaches, pears, Saskatoon berries, strawberries	WSP	40%	3	DWE
	novaluron	see RIMON 10 EC						
25547	NUSTAR	flusilazole	f	apples	DF	20%	3	DUQ
28905	OBERON	spiromesifin	a	strawberries	SC	240 g/L	3	BCZ
28146	OPAL	potassium salts of fatty acids	a,i	filberts/hazelnuts, pecans, sweet chestnuts, walnuts	SC	47%	4	OMD
14225	ORTHENE 75% SP	acephate	i	Saskatoon berries	SP	75%	3	TOA
	oxamyl	see VYDATE L						
	Pantoea agglomerans	see BLOOMTIME BIOLOGICAL FD						
25397	PENNCOZEB 75 DF	mancozeb	f	apples	WDG	75%	4	UPI
	permethrin	see AMBUSH 500 EC, PERM-UP, POUNCE 384 EC						

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[1] a – acaracide, miticide; b – bactericide; ba - bacterial antagonist; f – fungicide ; h – herbicide; i – insecticide; n – nematicide; r – rodenticide; md – mating disrupter; pgr – plant growth regulator; s – slug bait; tr – taste repellent.

[2] Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; FDP – fast dissolving powder; FL – flowable; GR – granule; L – liquid; P – particulate; SC – suspension concentrate; SG – soluble granules; SN – solution; SU – suspension (flowable); WDG – water dispersible granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

[3] See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Table 13-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
28877	PERM-UP	permethrin	i	apples, grapes, peaches, pears	EC	384 g/L	3	UPI
	pheromone	see ISOMATE-M ROSSO, ISOMATE-M100, ISOMATE-GBM PLUS, ISOMATE-P , ISOMATE-CM/OFM TT						
	phosalone	see ZOLONE FLO						
	phosmet	see IMIDAN 50 WP						
28715	PIC PLUS FUMIGANT	chloropicrin	n,f	strawberries, raspberries	L	85.1%	2	HND
20087	POLYRAM DF	metiram	f	apples, grapes	WDG	80%	4	BAZ, ENG
	potassium bicarbonate	see MILSTOP						
	potassium salts of fatty acids	See OPAL						
16688	POUNCE 384 EC	permethrin	i	apples, grapes, peaches, pears	EC	384 g/L	4	UAG
30051	PRESIDIO	fluopicolide	f	grapes	SU	39.5%	2	VAJ
27985	PRISTINE WG	boscalid + pyraclostrobin	f	pome fruit group, stone fruit group, berry crop group, strawberries, grapes	WG	25.2% + 12.8%	2	BAZ
	prohexadione calcium	see APOGEE						
	propiconazole	see MISSION 418 EC, TOPAS, JADE						
	Pseudomonas syringae	see BIO-SAVE 10 LP						
27666	PURESPRAY GREEN SPRAY OIL 13E	mineral oil	i, f	apples, apricots, blueberries, grapes, peaches, pears, plums, sour cherries		99%	4	PCV
	pyraclostrobin	see CABRIO EG						
	pyraclostrobin + boscalid	see PRISTINE WG						
	pyridaben	see NEXTER						
	pyrimethanil	see SCALA SC						
	quinoxyfen	see QUINTEC						
29755	QUINTEC	quinoxyfen	f	grapes, sour cherries, strawberries	SC	250 g/L	3	DWE
11670	RAMIK BROWN	diphacinone	r	orchards	pellets	0.005%	4	UAG, HOK
29074	REVUS	mandipropamid	f	grapes	SU	250 g/L	3	SYZ
28474	RIDOMIL GOLD 480 SL	metalaxyl-m + s-isomers	f	non-bearing apples, blueberries, raspberries, strawberries	SN	480 g/L	3	SYZ
28893	RIDOMIL GOLD MZ 68 WG	metalaxyl + mancozeb	f	grapes	WG	4% + 64%	3	SYZ

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[2] Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; FDP – fast dissolving powder; FL – flowable; GR – granule; L – liquid; P – particulate; SC – suspension concentrate; SG – soluble granules; SN – solution; SU – suspension (flowable); WDG – water dispersible granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

[3] See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Table 13-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
28881	RIMON 10 EC	novaluron	i	apples, apricots, blueberries, cherries, peaches, plums, strawberries	EC	10%	2	CRE
15738	RIPCORD 400 EC	cypermethrin	i	apples, grapes, peaches, pears, strawberries	EC	407 g/L	3	BAZ
15213	ROVRAL	iprodione	f	apricots, cherries, grapes, peaches, plums, raspberries, strawberries	WP	500 g/kg	3	BCZ
28011	SCALA SC	pyrimethanil	f	apples, pears, grapes, strawberries	SC	400 g/L	3	BCZ
29528	SCHOLAR 230 SC	fludioxonil	f	apples, apricots, cherries, pears, peaches, plums	SC	230 g/L	4	SYN
25343	SENATOR 70 WP	thiophanate-methyl	f	raspberries	WP	70%	4	ENG
28626	SERENADE ASO	*Bacillus subtilis*	f	bushberries and caneberries crop group 13, strawberries, grapes	SU	1.34%	4	UAG
28549	SERENADE MAX	*Bacillus subtilis*	f	pome fruit crop group 11	WP	14.6%	4	UAG
29052	SILENCER 120 EC	lambda-cyhalothrin	i	apples, peaches, pears, strawberries	EC	120 g/L	2	MKC
27876	SEVIN XLR	carbaryl	i	apples, apricots, blueberries, cherries, grapes, peaches, pears, plums, raspberries	SU	466 g/L	3	BCZ
13258	SKOOT	thiram	tr	apples, walnuts		120 g/L	4	PLG
30025	SLUGGO PROFESSIONAL	ferric phosphate	s	grapes, strawberries	GR	0.76%	4	ENG
23323	SNIPER	azinphosmethyl	i	raspberries	WSP	50%	2	UAG, LOI
26257	SOVRAN	kresoxim-methyl	f	apples, pears, grapes	WDG	50%	4	ENG, BAZ
	spinetoram	see DELEGATE WG						
	spinosad	see SUCCESS 480 SC, ENTRUST 80 W, GF-120 NF						
	spirodiclofen	see ENVIDOR 240 SC						
	spiromesifin	see OBERON						
	spirotetramat	see MOVENTO 240 SC						
	Streptomyces lydicus strain WYEC108	see ACTINOVATE SP						
10305	STREPTOMYCIN 17	streptomycin sulfate	b	apples, pears	WP	25.2%	4	UAG, LOI

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[2] Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; FDP – fast dissolving powder; FL – flowable; GR – granule; L – liquid; P – particulate; SC – suspension concentrate; SG – soluble granules; SN – solution; SU – suspension (flowable); WDG – water dispersible granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

[3] See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Table 13-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
	streptomycin sulfate	see STREPTOMYCIN 17						
26835	SUCCESS 480 SC	spinosad	i	pome fruit group, apricots, blueberries, cherries, currants, elderberries, grapes, plums, raspberries, Saskatoon berries, sea buckthorn, strawberries	SC	480 g/L	4	DWE
	sulphur	see KUMULUS DF, MICROSCOPIC SULPHUR, MICROSCOPIC WETTABLE SULPHUR, MICROTHIOL DISPERSS, LIME SULPHUR						
9542 14981	SUPERIOR 70 OIL	mineral oil	a,i	apples, apricots, blueberries, peaches, pears, plums, sour cherries, Saskatoon berries	EC	99%	4	BAT, UAG, LOI
24613	SUPRA CAPTAN 80 WDG	captan	f	apples, apricots, blueberries, grapes, peaches, pears, plums, raspberries, cherries, strawberries	WDG	80%	3	UAG, LOI
27469	SURROUND WP	kaolin	i	apples, filberts/ hazelnuts, grapes, pecans, pears, raspberries, strawberries, sweet chestnuts, walnuts	WP	95%	4	BAT
28189	SWITCH 62.5 WG	cyprodinil + fludioxonil	f	blueberries, Saskatoon berries, strawberries, raspberries	WG	37.5% + 25%	3	SYZ
28351	SYLLIT 400 FL	dodine	f	pears	SN	402 g/L	4	NOC
27435	TANOS 50 DF	famoxadone + cymoxanil	f	raspberries	DF	25% + 25%	3	DUQ
	tebufenozide	see CONFIRM 240 F						
	thiabendazole	see MERTECT SC						
	thiacloprid	see CALYPSO 480 SC						
	thiamethoxam	see ACTARA 25 WG						
23453	THIONEX EC	endosulfan	i	strawberries	EC	400 g/L	3	MKC
14617	THIONEX 50 W	endosulfan	i	apricots, cherries, pears, plums, strawberries	WP	50%	3	UAG. LOI
	thiophanate methyl	see SENATOR 70 WP						
	thiram	see SKOOT						

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[2] Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; FDP – fast dissolving powder; FL – flowable; GR – granule; L – liquid; P – particulate; SC – suspension concentrate; SG – soluble granules; SN – solution; SU – suspension (flowable); WDG – water dispersible granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

[3] See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Table 13-5. Pesticides Used on Fruit Crops in Ontario (cont'd)

Registration no.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Crop recommended registrations	Formulation[2]	Guaranteed active	Ont. class[3]	Registrant code[4]
30163	TOPAS	propiconazole	f	apricots, blueberries, cherries, peaches, plums, Saskatoon berries, strawberries	EC	250 g/L	3	SYZ
	tri-basic copper sulphate	**see COPPER 53 W**						
	trifloxystrobin	**see FLINT 50 WG**						
	triforine	**see FUNGINEX DC**						
28795	UP-CYDE 2.5 EC	cypermethrin	i	apples, peaches, pears, strawberries	EC	250g/L	3	UPI
25509	VANGARD 75 WG	cyprodinil	f	apples, apricots, grapes, peaches, plums	WDG	75%	3	SYN
29128	VAPAM HL	metam sodium	f, h, n	fruit crops (before planting)	L	42%	4	UAG, AMV
26533	VIROSOFT CP4	*Cydia pomonella* granulovirus	i	apples	SU	0.07%	4	BPT
29765	VIVANDO SC	metrafenone	f	grapes	SC	300 g/L	2	BAZ
17995	VYDATE L	oxamyl	i,n	non-bearing apples, raspberries	L	240 g/L	2	DUQ
	zinc phosphide	**see BARTLETT WAXED MOUSE BAIT**						
17983	ZOLONE FLO	phosalone	i	apples	FL	500 g/L	3	CAU
	zoxamide + mancozeb	**see GAVEL 75 DF**						

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[1] a – acaracide, miticide; b – bactericide; ba - bacterial antagonist; f – fungicide ; h – herbicide; i – insecticide; n – nematicide; r – rodenticide; md – mating disrupter; pgr – plant growth regulator; s – slug bait; tr – taste repellent.

[2] Symbols used are: DF – dry flowable; DG – dry granules; DIS – dispenser units; EC – emulsifiable concentrate; FDP – fast dissolving powder; FL – flowable; GR – granule; L – liquid; P – particulate; SC – suspension concentrate; SG – soluble granules; SN – solution; SU – suspension (flowable); WDG – water dispersible granule; WG – wettable granular; WP – wettable powder; WSP – water soluble packets.

[3] See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Table 13-6. Thinners and Plant Growth Regulators Used on Fruit Crops in Ontario

Registration no.	BRAND or TRADE NAME*	Common name or active ingredient	Use[1]	Guaranteed % (active unless stated)	Formulation[2]	Ont. Class[3]	Registrants code[4]
13167	AMID-THIN	1-napthaleneacetamide	PGR, TH	8.3%	WP	4	AMV, UAG
28042	APOGEE	prohexadione calcium	PGR	27.5 %	WG	4	BAZ
29210	CILIS PLUS	6-benzylaminopurine	PGR, TH	2.0%	L	4	FAL, BAT
11580	ETHREL	ethephon	PGR	240 g/L	L	4	BCZ
27653	FALGRO TABLET	gibberellic acid	PGR	1.0 g/tablet	tablets	4	NOC
14630	FRUITONE N	1-napthaleneacetic acid	PGR, TH	3.1%		4	AMV, UAG
28851	MAXCEL	6-benzyladenine	PGR, TH	1.9%	SN	4	VBC, VAJ
29187	PERLAN	6-benzylaminopurine, gibberellins $A_4 + A_7$	PGR	1.8% BA 1.8% GA	SN	4	FAL, BAT
16636	PROMALIN	benzyladenine gibberellins $A_4 + A_7$	PGR	1.8% BA 1.8% GA	EC	4	VBC, VAJ
25609	RETAIN	aviglycine hydrochloride	PGR	15%	SP	3	VBC, VAJ
27469	SURROUND WP	kaolin	CP	95%	WP	4	ENG

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[1] PGR – plant growth regulator; TH – thinner; CP – crop protectant.

[2] L – liquid; SP – soluble powder; SN – solution; WG- Wettable granular; WP – wettable powder.

[3] Farmers must be certified to buy and use pesticides in class 2 and class 3. See Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4*, page 285.

[4] Registrant or representative's code: See Table 13-8. *Pest Control Product Companies*, page 286.

Pesticide Classification in Ontario

Under the *Pesticides Act* and Regulation 63/09, the Ontario Ministry of the Environment classifies federally registered pesticides into one of eleven classes. Each class has defined education, licensing and/or permit requirements, and restrictions on its use and sale in Ontario. Pesticides are classified on the basis of their toxicity, environmental or health hazard, persistence, concentration, how they are used, and their container size. The classification of each product in the publication can be found in Table 13-5. *Pesticides Used on Fruit Crops in Ontario,* page 272 and Table 13-6. *Thinners and Plant Growth Regulators Used on Fruit Crops in Ontario,* page 284.

Class 2 and 3 pesticides are the most hazardous. Table 13-7. *Pesticide Classification Schedules in Ontario: Classes 2, 3, and 4,* on this page, describes the hazard criteria for the classes of pesticides used in this publication. Regulation 63/09 of the *Pesticides Act* makes it mandatory for farmers to be certified to buy and use Class 2 or 3 pesticides on their farms. Pesticide storage requirements also vary by class. Detailed descriptions of each classification can be found at: *www.ene.gov.on.ca/en/land/pesticides/class-pesticides.php.*

A farmer can become a certified farmer by attending a one-day Grower Pesticide Safety Course and passing the certification examination. To become a certified farmer, visit the Ontario Pesticide Education Program website at *www.opep.ca* or call 1-800-652-8573.

Table 13-7. Pesticide Classification Schedules In Ontario: Classes 2, 3, and 4

Provincial class	Federal class	Hazard description	Hazard criteria
2	Restricted or Commercial	Very Hazardous	Meets at least one of the criteria: • fumigant gas • acute oral LD50 less than or equal to 50 mg/kg • acute dermal LD50 less than or equal to 100 mg/kg • soil half-life greater than or equal to six months
3	Restricted or Commercial	Moderately Hazardous	Meets at least one of these criteria: • acute oral LD50 greater than 50 and less than or equal to 500 mg/kg • acute dermal LD50 greater than 100 and less than or equal to 1,000 mg/kg • soil half-life greater than one month and less than six months
4	Restricted or Commercial	Less or Least Hazardous	Meets all of these criteria: • acute oral LD50 greater than 500 mg/kg • acute dermal LD50 greater than 1,000 mg/kg • soil half-life less than or equal to one month

Source: Grower Pesticide Safety Course Update 2009.

Table 13-8. Pest Control Product Companies

Code*	Registrant or agent	Website	Contact number
AFG	AEF Global Inc.	*www.aefglobal.com*	418-838-4441
AMV	AMVAC Chemical Corporation	*www.ecozin.com* (U.S. website)	323-264-3910
BAT	Bartlett, N.M. Inc.	*www.bartlett.ca*	1-800-263-1287
BAZ	BASF Canada Inc.	*www.agsolutions.ca*	1-877-371-2273
BCZ	Bayer CropScience Inc.	*www.bayercropscience.ca*	1-877-938-3737
BPT	BioTepp Inc.	*www.biotepp.com*	1-418-659-4446
BUL	Buckman Laboratories of Canada Ltd.	*www.buckman.com*	1-450-424-4404
BWI	Bioworks	*www.bioworksbiocontrol.com*	585-641-0581
CAU	Cheminova Canada Inc.	*www.cheminova.com*	1-888-316-6260
CRE	Chemtura Company	*www.chemtura.com*	403-279-7477
CRU	Certis USA	*www.certisusa.com* (U.S. website)	1-800-847-5620
DAS	Douglas Agricultural Services, Inc.		519-427-8195
DUQ	E.I. du Pont Canada Company	*www.dupont.ca/ag*	1-800-667-3925
DWE	Dow AgroSciences Canada	*www.dowagro.com*	1-800-667-3852
ENG	Engage Agro Corp.	*www.engageagro.com*	1-866-613-3336
FAL	Fine Agrochemicals Inc.	*www.fine-americas.com*	1-925-932-8800
GOW	Gowan Company	*www.gowanco.com*	1-800-883-1844
HND	Hendrix and Dail Inc.	*www.hendrixanddail.com*	1-831-637-0195
HOK	Hacco Inc.	*www.hacco.com* (U.S. website)	1-920-326-2461
ISK	ISK Biosciences Corporation	*www.iskbc.com* (U.S. website)	1-216-357-4100
JET	Jet Harvest Solutions	*www.jetharvest.com*	1-877-866-5773
LVP	Loveland Products Canada Inc.	*www.uap.ca*	
MKC	Makhteshim-Agan	*www.manainc.ca*	1-905-304-1168
NAP	Northwest Agricultural Products	*www.nap-chem.com*	1-877-357-4461
NIJ	Natural Industries Inc.	*www.naturalindustries.com*	1-281-580-1643
NOC	Norac Concepts	*www.noracconcepts.com*	1-519-821-3110
NSC	Nippon Soda Co., Ltd.	*www.nippon-soda.co.jp* (Japan website)	1-212-490-0350
OMD	Omex Agriculture Inc.	*www.omex.co.uk/canada/home/aspx*	204-477-4052
PBC	Pacific Biocontrol	*www.pacificbiocontrol.com* (U.S. website)	360-571-2247
PLG	Plant Products Co. Ltd.	*www.plantprod.com*	1-905-793-7000
PCV	Petro-Canada Lubricants	*www.purespraygreen.com*	1-905-804-3600
SYZ	Syngenta Crop Protection	*www.syngenta.ca*	1-877-964-3682
TOA	Arysta LifeScience	*www.arystalifescience.ca*	1-866-761-9397 1-519-766-1117
UAG	United Agri Products Canada Inc.	*www.uap.ca*	1-800-265-4624
UPI	United Phosphorus Inc.		1-800-438-6071
VAJ	Valent Canada Inc.	*www.valent.ca*	1-519-767-9262
VAR	Univar Canada Ltd.	*www.univarcanada.com*	1-800-265-7671
VBC	Valent Biosciences	*www.valent.com*	1-800-682-5368

The three-letter manufacturers' codes represent the codes listed in Table 13-5. *Pesticides Used on Fruit Crops in Ontario*, page 272 and Table 13-6. *Thinners and Growth Regulators Used on Fruit Crops in Ontario*, page 284.

For Canadian labels, contact the registrant or search the PMRA website at *www.pmra-arla.gc.ca/english/main/search-e.html*.

14. Appendices

APPENDIX A: Suppliers of Pest Monitoring Equipment and Biological Control Agents

This list includes sources of weather monitoring equipment, pest monitoring supplies and biological control agents. For a more extensive list of beneficial insects and mite suppliers, see the OMAFRA website at *www.ontario.ca/crops*. This is a partial list and does not imply endorsement or recommendation by the Ontario Ministry of Agriculture, Food and Rural Affairs of the companies listed.

Company	Address	Telephone/Fax/E-mail	Products
Biobest Canada Ltd. *www.biobest.ca*	2020 Foxrun Rd. R.R. #4 Leamington, ON N8H 3V7	Tel: 519-322-2178 Fax: 519-322-1271 E-mail: info@biobest.ca	• beneficial insects, mites, nematodes • insect traps and pheromones • bumblebee hives for pollination
Cooper Mill Ltd. *www.coopermill.com*	R.R. # 3 Madoc, ON K0K 2K0	Tel: 613-473-4847 Fax: 613-473-5080 E-mail: ipm@coopermill.com	• pheromone lures and traps
Gempler's *www.gemplers.com*	1125 Deming Way P.O. Box 44993 Madison, WI USA 53744-4993	Tel: 608-662-3301 Toll-free: 1-800-382-8473 Fax: 608-662-3360 Toll-free: 1-800-551-1128	• weather monitoring equipment • pheromone lures and traps • apple maggot spheres • tangle traps • magnifiers • tally counters
Great Lakes IPM, Inc. *www.greatlakesipm.com*	10220 Church Rd. E. Vestaburg, MI USA 48891	Tel: 989-268-5693/5911 Toll-free: 1-800-235-0285 Fax: 989-268-5311 E-mail: glipm@greatlakesipm.com	• apple scab monitoring equipment • pheromone lures and traps • apple maggot spheres • tangle traps • magnifiers • tally counters • insect sweep nets • field diagnostic equipment
Koppert Canada Ltd. *www.koppertonline.ca*	50 Ironside Cres. #2 Scarborough, ON M1X 1G4	Tel: 1-800-567-4195 Fax: 416-291-0902 E-mail: info@koppert.ca	• beneficial insects, mites • insect traps • BioWorks products
Natural Insect Control *www.naturalinsectcontrol.com*	3737 Netherby Rd. Stevensville, ON L0S 1S0	Tel: 905-382-2904 Fax: 905-382-4418 E-mail: nic@niagara.com	• beneficial insects, mites and nematodes • pheromone lures and traps • mating disruption devices • bird houses
N.M. Bartlett Inc. *www.bartlett.ca*	4509 Bartlett Rd. Beamsville, ON L0R 1B1	Tel: 905-563-8261 Toll-free: 1-800-767-8658 Fax: 905-563-7882 E-mail: info@bartlett.ca	• pheromone lures and traps • mating disruption devices
Contech Enterprises Inc. *www.contech-inc.com*	7572 Progress Way Delta, BC V4G 1E9	Tel: 604-940-9944 Toll-free: 1-800-767-8658 Fax: 604-940-9433 E-mail: sales@contech-inc.com	• pheromone lures and traps
Plant Products Co. Ltd. *www.plantprod.com*	314 Orenda Rd. E. Brampton, ON L6T 1G1	Tel: 1-800-387-2449 Fax: 905-793-9157 E-mail: sales@plantprod.com	• beneficial insects and mites • magnifiers
Solida Distributors *www.solida.ca*	480 rue St-Antoine St. Ferreol-les-Neiges, QC G0A 3R0	Tel: 418-826-0900 Fax: 418-826-0901 E-mail: info@solida.ca	• pheromone traps and lures • tangle traps, insect trap coating • hand lens magnifiers • tally counters • product technical support
Warwick Orchards and Nursery	7056 Egremont Rd. R.R. # 8 Watford, ON N0M 2S0	Tel: 519-849-6730 Fax: 519-849-6731 E-mail: warwickorchards@brktel.on.ca	• DeWitt leaf wetness sensor

APPENDIX B: Safety Supply Companies

This is a list of safety supply companies in Ontario providing protective clothing and personal protective equipment. Ask safety supply companies for help to select protective clothing and personal protective equipment. This is a partial list and does not imply endorsement or recommendation by the Ontario Ministry of Agriculture, Food and Rural Affairs of the companies listed.

Safety Supply Companies in Ontario Providing Protective Clothing and Personal Protective Equipment

Company	Address	Telephone/Fax/E-mail	
3-M Canada Company Occupational Health and Environmental Safety *www.3m.ca*	300 Tartan Drive London, ON N5V 4M9	Toll-free: Toll-free Fax:	1-800-364-3577 1-800-603-7758
Acklands Grainger *www.acklandsgrainger.com*	90 W. Beaver Creek Rd. Richmond Hill, ON L4B 1E7	Tel: Toll-free: Fax: E-mail:	905-731-5516 1-866-248-8801 905-731-2798 contact@agi.ca
Dupont Personal Protection *www.personalprotection.dupont.com*	Box 2200 Streetsville Mississauga, ON L5M 2H3	Tel: Toll-free: Fax: Toll-free Fax:	905-821-3300 1-800-387-9326 905-821-5110 1-866-765-5357
Dutch Industries "Protect-Air Cab Filter" *www.dutchopeners.com* *www.hurontractor.com*	Huron Tractor 305 Main Street N. Exeter, ON N0M 1S3	Tel: Fax:	519-235-1115 519-235-1939
Hamisco *www.hamisco.com*	3392 Wonderland Rd. S. London, ON N6L 1A8	Tel: Toll-free: Fax:	519-652-9800 1-800-668-9800 519-652-9661
Levitt-Safety (Eastern) Ltd. *www.levitt-safety.com*	2872 Bristol Circle Oakville, ON L6H 5T5	Tel: Toll-free: Fax:	905-829-3299 1-888-453-8488 905-829-2919
Mitt & Robe Co. Ltd. *www.mittrobe.ca*	751 Norfolk St. N. Simcoe, ON N3Y 3R6	Tel: Toll-free: Fax: E-mail:	519-428-4050 1-877-893-6565 519-428-5142 sales@mittrobe.ca
MSA Canada *www.msanet.com*	222-5535 Eglinton Ave. W. Toronto, ON M9C 5K5	Tel: Toll-free: Fax:	416-620-4225 1-800-MSA-2222 905-238-4151
Plant Products Co. Ltd. *www.plantprod.com*	314 Orenda Rd. Brampton, ON L6T 1G1	Tel: Toll-free: Fax:	905-793-7000 1-800-387-2449 905-793-9157
Safety Express *www.safetyexpress.com*	4190 Sladeview Cres. Unit 1 and 2 Mississauga, ON L5L 0A1	Tel: Toll-free: Fax: E-mail:	905-608-0111 1-800-465-3898 905-608-0091 info@safetyexpress.com
The St. George Company (Suppliers of Kasco Helmets) *www.thestgeorgeco.com*	20 Consolidated Dr. P.O. Box 430 Paris, ON N3L 3T5	Tel: Toll-free: Fax: E-mail:	519-442-2046 1-800-461-4299 519-442-7191 sales@thestgeorgeco.com

APPENDIX C: Accredited Soil-Testing Laboratories in Ontario

The following labs are accredited to perform soil tests for pH, buffer pH, potassium, phosphorus, magnesium and nitrate-nitrogen on Ontario soils.

Laboratory Name	Address	Telephone/Fax/E-mail	Contact
A & L Canada Laboratories Inc. *www.alcanada.com*	2136 Jetstream Rd. London, ON N5V 3P5	Tel: 519-457-2575 Fax: 519-457-2664 E-mail: aginfo@alcanada.com	Greg Patterson Ian McLachlin
SGS Agri-Food Laboratories *www.agtest.com*	503 Imperial Rd. Unit #1 Guelph, ON N1H 6T9	Tel: 519-837-1600 Toll-free: 1-800-265-7175 Fax: 519-837-1242 E-mail: lab@agtest.com	Jack Legg Papken Bedirian
Brookside Laboratories, Inc. *www.blinc.com*	308 South Main St. New Knoxville, Ohio USA 45871	Tel: 419-753-2448 Fax: 419-753-2949 E-mail: jbrackman@blinc.com	Jackie Brackman Mark Flock
Exova Accutest Laboratory Exova Canada Inc. *www.exova.ca*	8-146 Colonnade Rd. Ottawa, ON K2E 7Y1	Tel: 613-727-5692, ext. 317 Fax: 613-727-5222 E-mail: lorna.wilson@exova.com	Lorna Wilson
FoReST Laboratory *http://lucas.lakeheadu.ca/forest*	955 Oliver Rd. BB1005D Thunder Bay, ON P7B 5E1	Tel: 807-343-8639 Fax: 807-343-8116 E-mail: soilslab@lakeheadu.ca	Claire Riddell Joel Symonds
University of Guelph Laboratory Services *www.labservices.uoguelph.ca/units/soil-nutrient*	University of Guelph P.O. Box 3650, 95 Stone Rd. W. Guelph, ON N1H 8J7	Tel: 519-767-6299 Fax: 519-767-6240 E-mail: aflinfo@uoguelph.ca	Nick Schrier
Stratford Agri Analysis *www.stratfordagri.ca*	1131 Erie St. Box 760 Stratford, ON N5A 6W1	Tel: 519-273-4411 1-800-323-9089 Fax: 519-273-2163 E-mail: info@stratfordagri.ca	Keith Lemp Mark Aikman

There is no official accreditation in Ontario for tissue analysis but all the accredited soil-testing labs are monitored for proficiency on tissue analyses.

APPENDIX D: Diagnostic Services

Samples for disease diagnosis, insect or weed identification, nematode counts and *Verticillium* testing can be sent to:

Pest Diagnostic Clinic
Laboratory Services Division
University of Guelph
95 Stone Rd. W.
Guelph, ON N1H 8J7
Tel: 519-767-6256
Fax: 519-767-6240
E-mail: pdc@lsd.uoguelph.ca

Payment must accompany samples at the time of submission. Submission forms are available at *www.uoguelph.ca/pdc*.

Fee schedule

To obtain information on the fee schedule, visit *www.uoguelph.ca/pdc* or phone the Pest Diagnostic Clinic.

How to Sample for Nematodes

Soil

When to sample

Soil and root samples can be taken at any time of the year that the soil is not frozen. In Ontario, nematode soil population levels are generally at their highest in May and June, and again in September and October.

How to sample soil

Use a soil sampling tube, trowel or narrow-bladed shovel to take samples. Sample soil to a depth of 20–25 cm (8–10 inches). If the soil is bare, remove the top 2 cm (1 inch) prior to sampling. A sample should consist of 10 or more subsamples combined. Mix well, then take a sample of ½–1 L (1 pint–1 quart) from this. No single sample should represent more than 2.5 ha (6.25 acre). Mix subsamples in a clean pail or plastic bag.

Sampling pattern

If living crop plants are present in the sample area, take samples within the row and from the area of the feeder root zone (with trees, this is the drip line).

Number of Subsamples

Based on the total area sampled:

500 m^2 (5,400 ft^2)	10 subsamples
500 m^2–0.5 ha (5,400 ft^2–1.25 ac)	25 subsamples
0.5 ha–2.5 ha (1.25–6.25 ac)	50 subsamples

Roots

From small plants, sample the entire root system plus adhering soil. For large plants, 10–20 g (½–1 oz.) dig fresh weight from the feeder root zone and submit.

Problem areas

Take soil and root samples from the margins of the problem area where the plants are still living. If possible, also take samples from healthy areas in the same field. If possible, take both soil and root samples from problem and healthy areas in the same field.

Sample handling

Soil samples

Place in plastic bags as soon as possible after collecting.

Root samples

Place in plastic bags and cover with moist soil from the sample area.

Storage

Store samples at 5°C–10°C (40°F–50°F) and do not expose them to direct sunlight or extreme heat or cold (freezing). Only living nematodes can be counted. Accurate counts depend on proper handling of samples.

Submitting Plant for Disease Diagnosis or Identification

Sample submission forms

Forms can be obtained from your local Ontario Ministry of Agriculture, Food and Rural Affairs office. Carefully fill in all of the categories on the form. In the space provided, draw the most obvious symptom and the pattern of the disease in the field. It is important to include the cropping history of the area for the past three years and this year's pesticide use records.

Choose a complete, representative sample showing early symptoms. Submit as much of the plant as is practical, including the root system, or several plants showing a range of symptoms. If symptoms are general, collect the sample from an area where they are of intermediate severity. Completely dead material is usually inadequate for diagnosis.

With plant specimens submitted for identification, include at least a 20–25 cm sample of the top portion of the stem with lateral buds, leaves, flowers or fruits in identifiable condition. Wrap plants in newspaper and put in a plastic bag. Tie the root system off in a separate plastic bag to avoid drying out and contamination of the leaves by soil. Do not add moisture, as this encourages decay in transit. Cushion specimens and pack in a sturdy box to avoid damage during shipping. Avoid leaving specimens to bake or freeze in a vehicle or in a location where they could deteriorate.

Delivery

Deliver to the Pest Diagnostic Clinic as soon as possible by first class mail or by courier at the beginning of the week.

Submitting Insect Specimens for Identification

Collecting Samples

Place dead, hard-bodied insects in vials or boxes and cushion with tissues or cotton. Place soft-bodied insects and caterpillars in vials containing alcohol. Do not use water, as this results in rot. Do not tape insects to paper or send them loose in an envelope.

Place live insects in a container with enough plant "food" to support them during transit. Be sure to write "live" on the outside of the container.

UNIVERSITY of GUELPH
LABORATORY SERVICES

Sample Submission Form

95 Stone Road West
Guelph, ON N1H 8J7
Tel: (519) 824-4120 ext. 57256
Fax: (519) 767-6240
Web: www.guelphlabservices.com

Pest Diagnostic Clinic

LABORATORY USE ONLY: **LS Form: SubP07/03/27** **Pg. 1 of**

Rec'd: By:____________ **Date Received:** ____________

Delivered By: ☐ **Mail** ☐ **Courier** ☐ **In-Person**

LS Sample No: ____________ **to** ____________

Payment Rec'd: $____________ **Receipt #:**____________

Submitted By:			Owner (if different from submitter):		
Business Name (if applicable):			Business Name (if applicable):		
Street:			Street:		
City:	Prov:	Postal Code:	City:	Prov:	Postal Code:
Tel: ( ) -	Fax: ( ) -		Tel: ( ) -	Fax: ( ) -	
Email:			Email:		

Unless otherwise indicated, report and invoice will be sent to submitter

Report to: ☐ Submitter ☐ Owner Required Report Format: ☐ Fax ☐ E-Mail ☐ Mail

Invoice to: ☐ Submitter ☐ Owner Quotation #: ________ Purchase Order / U of G G/L code:____________

Services Required: ☐ Nematode Count ☐ Nematode Count from Roots ☐ SCN Cyst & Egg Count
☐ Plant Disease Diagnosis ☐ Insect Identification ☐ Plant Identification ☐ DNA Multiscan

If submitting a water sample, please answer the following question:

Is the purpose of the water test request to assess the quality of water for human consumption? ☐ **YES** ☐ **NO**

Date:____________ **Signature:**____________________

Plant or Host Affected:		Cultivar/Variety:	Grower/Field sample #:
		Location of Plant (i.e. greenhouse, field, orchard, garden, etc.):	
Size of Planting:	% of Plants Affected:	Symptoms First Appeared in Past: ☐ Days ☐ Weeks ☐ Months ☐ Years	Degree of Injury: ☐ Severe ☐ Moderate ☐ Light
Cropping History:		Future Crop:	

Describe the problem in detail (i.e. symptoms, plant parts affected, distribution of symptoms):

Were chemicals applied? Please specify type of product(s) used and date(s) of application:

Additional comments and specific requests:

Additional Sheet(s) Attached:

APPENDIX E: Ontario Ministry of Agriculture, Food & Rural Affairs Fruit Crop Advisory Staff

Agroforestry Specialist	Todd Leuty	Tel: 519-826-3215	todd.leuty@ontario.ca
Apple Specialist	Leslie Huffman	Tel: 519-738-1256	leslie.huffman@ontario.ca
Application Technology Specialist	Jason Deveau	Tel: 519-426-8934	jason.deveau@ontario.ca
Berry Crop Specialist	Pam Fisher	Tel: 519-426-2238	pam.fisher@ontario.ca
Crop Protection Program Lead	Denise Beaton	Tel: 519-826-6594	denise.beaton@ontario.ca
Entomology, Horticulture Program Lead	Hannah Fraser	Tel: 905-562-1674	hannah.fraser@ontario.ca
Fresh Market Quality Program Lead	Jennifer R. DeEll	Tel: 519-426-1408	jennifer.deell@ontario.ca
IPM Specialist – Specialty Crops	Melanie Filotas	Tel: 519-426-4434	melanie.filotas@ontario.ca
IPM Systems Specialist	Margaret Appleby	Tel: 613-475-5850	margaret.appleby@ontario.ca
Minor Use Coordinator	Jim Chaput	Tel: 519-826-3539	jim.chaput@ontario.ca
New Crop Development Specialist	Evan Elford	Tel: 519-426-4509	evan.elford@ontario.ca
Nutrient Management Horticulture Program Lead	Deanna Nemeth	Tel: 905-562-1170	deanna.nemeth@ontario.ca
Nutrition – Horticulture Program Lead	Christoph Kessel	Tel: 519-824-4120 ext. 52480	christoph.kessel@ontario.ca
Pathologist – Horticulture Program Lead	Michael Celetti	Tel: 519-824-4120 ext. 58910	michael.celetti@ontario.ca
Pome Fruit IPM Specialist	Kristy Grigg-McGuffin	Tel: 519-426-4322	kristy.grigg-mcguffin@ontario.ca
Soil Management Specialist	Anne Verhallen	Tel: 519-674-1614	anne.verhallen@ontario.ca
Tender Fruit and Grape IPM Specialist	Wendy McFadden-Smith	Tel: 905-562-3833	wendy.mcfadden-smith@ontario.ca
Tender Fruit and Grape Specialist	Kathryn Carter	Tel: 905-562-1639	kathryn.carter@ontario.ca
Transition Crop Specialist	Jim Todd	Tel: 519-426-3823	jim.todd@ontario.ca
Weed Management Program Lead – Horticulture	Kristen Callow	Tel: 519-674-1335	kristen.callow@ontario.ca

A complete list of Ontario Ministry of Agriculture, Food and Rural Affairs advisory staff is available on the OMAFRA website at *www.ontario.ca/crops*.

Agricultural Information Contact Centre

Provides province-wide, toll-free technical and business information to commercial farms, agri-businesses and rural businesses.

1 Stone Rd. W., Guelph, ON N1G 4Y2
Tel: 1-877-424-1300 Fax: 519-826-3442
E-mail: ag.info.omafra@ontario.ca

APPENDIX F: Ontario Ministry of the Environment – Regional Contact Information

Region/County	Address	Telephone/fax
Central Region Toronto, Halton, Peel, York, Durham, Muskoka, Simcoe	5775 Yonge St., 8th Floor Toronto, ON M2M 4J1	Tel: 416-326-6700 Toll-free: 1-800-810-8048 Fax: 416-325-6345
West-Central Region Haldimand, Norfolk, Niagara, Hamilton-Wentworth, Dufferin, Wellington, Waterloo, Brant	Ontario Government Building 119 King St. W., 12th Floor Hamilton, ON L8P 4Y7	Tel: 905-521-7640 Toll-free: 1-800-668-4557 Fax: 905-521-7820
Eastern Region Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville, Prescott & Russell, Stormont/Dundas & Glengarry, Haliburton, Peterborough, Kawartha Lakes, Northumberland, Renfrew, Ottawa, Lanark, District of Nipissing (Twp. of South Algonquin)	1259 Gardiners Rd., Unit 3 PO Box 22032 Kingston, ON K7M 8S5	Tel: 613-549-4000 Toll-free: 1-800-267-0974 Fax: 613-548-6908
Southwestern Region Elgin, Middlesex, Oxford, Essex, Kent, Lambton, Bruce, Grey, Huron, Perth	733 Exeter Rd. London, ON N6E 1L3	Tel: 519-873-5000 Toll-free: 1-800-265-7672 Fax: 519-873-5020
Northern Region (East) Manitoulin, Nipissing, Parry Sound, Sudbury, Algoma (East), Timiskaming, Sault Ste. Marie	199 Larch St., Ste. 1201 Sudbury, ON P3E 5P9	Tel: 705-564-3237 Toll-free: 1-800-890-8516 Fax: 705-564-4180
Northern Region (West) Algoma (West), Cochrane, Kenora, Rainy River, Timmins, Thunder Bay	435 James St. S., Ste. 331 Thunder Bay, ON P7E 6S7	Tel: 807-475-1205 Toll-free: 1-800-875-7772 Fax: 807-475-1745
Standards Development Branch	Pesticides Section 40 St. Clair Ave. W. 7th Floor Toronto, ON M4V 1L5	Tel: 416-327-5519 Fax: 416-327-2936
Approvals Branch	Pesticides Licensing 2 St. Clair Ave. W. 12A Floor Toronto, ON M4V 1L5	Tel: 416-314-8001 Toll-free: 1-800-461-6290 Fax: 416-314-8452

APPENDIX G: Other Contacts

AGRICULTURE & AGRI-FOOD CANADA RESEARCH CENTRES

www.agr.gc.ca/index_e.php

Eastern Cereals and Oilseeds Research Centre
960 Carling Ave.
Ottawa, ON K1A 0C6
Tel: 613-759-1858

Greenhouse and Processing Crops Centre
2585 County Road 20
Harrow, ON N0R 1G0
Tel: 519-738-2251

Southern Crop Protection and Food Research Centre
1391 Sandford St.
London, ON N5V 4T3
Tel: 519-457-1470

Vineland Research Farm
4902 Victoria Ave. N.
Vineland, ON L0R 2E0
Tel: 905-562-4113

Delhi Research Farm
Box 186 Schafer Rd.
Delhi, ON N4B 2W9
Tel: 519-582-1950

CANADIAN FOOD INSPECTION AGENCY REGIONAL OFFICES (PLANT PROTECTION)

www.inspection.gc.ca/english/toce.shtml

Belleville
345 College St. E.
Belleville, ON K8N 5S7
Tel: 613-969-3333

Brantford
625 Park Rd. N., Suite 6
Brantford, ON N3T 5P9
Tel: 519-753-3478

Hamilton
709 Main St. W., Ste. 101
Hamilton, ON L8S 1A2
Tel: 905-572-2201

London
19-100 Commissioners Rd. E.
London, ON N5Z 4R3
Tel: 519-691-1300

St. Catharines
395 Ontario St., PO Box 19
St. Catharines, ON L2N 7N6
Tel: 905-937-8232

Ottawa District
38 Auriga Dr., Unit 8
Ottawa, ON K2E 8A5
Tel: 613-274-7374, ext. 221

Toronto
1124 Finch Ave. W., Unit 2
Downsview, ON M3J 2E2
Tel: 416-665-5055

UNIVERSITY OF GUELPH

Main Campus
Guelph, ON N1G 2W1
Tel: 519-824-4120
www.uoguelph.ca

Alfred Campus
Alfred, ON K0B 1A0
Tel: 613-679-2218
Fax: 613-679-2423
www.alfredc.uoguelph.ca

Kemptville Campus
Kemptville, ON K0G 1J0
Tel: 613-258-8336
Fax: 613-258-8384
www.kemptvillec.uoguelph.ca

Ridgetown Campus
Ridgetown, ON N0P 2C0
Tel: 519-674-1500
www.ridgetownc.uoguelph.ca

Department of Plant Agriculture
www.plant.uoguelph.ca

Department of Plant Agriculture, Guelph
50 Stone Rd. W.
Guelph, ON N1G 2W1
Tel: 519-824-4120, ext. 56083
Fax: 519-763-8933

Department of Plant Agriculture, Simcoe
1283 Blueline Road, PO Box 587
Simcoe, ON N3Y 4N5
Tel: 519-426-7127
Fax: 519-426-1225

Department of Plant Agriculture, Vineland
4890 Victoria Ave. N., PO Box 7000
Vineland Station, ON L0R 2E0
Tel: 905-562-4141
Fax: 905-562-3413

Lab Services Division
95 Stone Rd. W., PO Box 3650
Guelph, ON N1H 8J7
Tel: 519-767-6299
www.uoguelph.ca/labserv/

Trace Organics and Pesticides
Tel: 519-767-6485

Pest Diagnostic Clinic
Tel: 519-767-6256

VINELAND RESEARCH AND INNOVATION CENTRE

4890 Victoria Ave. N.
Vineland Station, ON L0R 2E0
Tel: 905-562-0320
Fax: 905-562-0084
www.vinelandresearch.com

APPENDIX H: Production Insurance

Production Insurance (PI) covers production losses and yield reductions caused by insured perils. This includes adverse weather, disease, wildlife and insect infestations. Depending on the plan, coverage is available on a total-yield, dollar-value, or acreage-loss basis. Producers can choose the type and level of coverage that best meets their needs. When enrolled in PI, producers are guaranteed a level of production, based on their yield history and their chosen coverage level. Claims are paid when an insured peril causes a yield to fall below the guaranteed production.

In Ontario, Agricorp administers PI on behalf of the Government of Ontario and Agriculture and Agri-Food Canada. More than 16,000 producers and 2 million hectares (5 million acres) of Ontario farmland are insured each year.

Production Insurance is part of the suite of programs available under Growing Forward. In most plans, producers pay 40 percent of the total premium cost and none of the administration cost. Together, the federal and provincial governments contribute the other 60 percent. Administrative costs are fully funded by both levels of government.

PI is available to all Ontario farmers, landlords and sharecroppers who grow an eligible crop. Coverage is available on approximately 90 commercially grown crops in Ontario in the following sectors:

- forage
- fresh vegetables
- fruit
- grains and oilseeds
- processing vegetables
- specialty crops

For more information, please call Agricorp weekdays, 7 AM to 5 PM at 1-888-247-4999 or visit *www.agricorp.com.*

Agricorp
1 Stone Rd. W.
Box 3660, Stn. Central
Guelph, ON N1H 8M4

Tel: 1-888-247-4999
TTY: 1-877-275-1380
Fax: 519-826-4118
E-mail: contact@agricorp.com
www.agricorp.com

Ontario Crops Covered by Production Insurance	
Fruit Crops	
apples and apple trees	cherries (sweet, sour)
grapes and grape vines	peaches/nectarines
pears	plums
strawberries	
Vegetable Crops – Average Farm Yield or Total Production	
asparagus	broccoli
butternut squash (processing)	cabbages
carrots (fresh)	carrots (processing)
cauliflower	celery
cucumbers (processing)	green beans and wax beans (processing)
lettuce	lima beans (processing)
onions (seed, set, Spanish, yellow)	parsnips
peas (processing)	peppers (banana, bell)
potatoes (fresh)	potatoes (processing)
red beets (processing)	rutabagas
sweet corn (fresh)	sweet corn (processing)
tomatoes (fresh)	tomatoes (processing)
Fresh Market Vegetables – Acreage Loss	
Root Vegetables (red beets, carrots, celeriac, French shallots, green onions, leeks, Spanish & yellow onions, parsnips, radishes, rutabagas, turnips, sweet potatoes, garlic)	
Leafy Vegetables (Brussels sprouts, broccoli, cauliflower, broccoflower, celery, Chinese cabbages, summer & winter cabbage, lettuce, mesclun, spinach, kale)	
Fruiting Vegetables (cucumbers, eggplant, gherkins, melons, peppers, pumpkins, squash, tomatoes, watermelon, zucchinis)	
Other Vegetables (broad beans, green and wax beans, sweet corn, green peas)	
General Crops	
buckwheat	canola
coloured beans (black, cranberry, kidney, Japanese/other)	corn (grain, silage, organic options)
flax	forage
mustard	new forage seeding
peanuts	popping corn
rye	soybeans (tofu, natto and organic options available)
spring grain	seed corn
sorghum	spring wheat
sugar beets	sunflower
triticale	white beans
winter spelt, organic	winter wheat (soft white, hard white, soft red, hard red, organic options)
Specialty Crops	
hemp, industrial	honey
tobacco (black, burley, flue cured)	

APPENDIX I: The Metric System

Metric units

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1,000 metres = 1 kilometre (km)

Square Measures (area)

100 m × 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1,000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1,000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight-Volume Equivalents (for water)

(1.00 kg) 1,000 grams = 1 litre (1.00 L)
(0.5 kg) 500 g = 500 mL (0.5 L)
(0.1 kg) 100 g = 100 mL (0.1 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Weight Measures

1,000 milligrams (mg) = 1 gram (g)
1,000 g = 1 kilogram (kg)
1,000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry–Liquid Equivalents

1 cm^3 = 1 mL
1 m^3 = 1,000 L

Metric Conversions

5 mL = 1 tsp
15 mL = 1 tbsp
28.5 mL = 1 Imp. fl. oz.

Application rate conversions

Metric to Imperial or U.S. (Approximate)

litres per hectare × 0.09 = Imp. gallons per acre
litres per hectare × 0.11 = U.S. gallons per acre
litres per hectare × 0.36 = Imp. quarts per acre
litres per hectare × 0.43 = U.S. quarts per acre
litres per hectare × 0.71 = Imp. pints per acre
litres per hectare × 0.86 U.S. pints per acre
millilitres per hectare × 0.014 = U.S. fluid ounces per acre
grams per hectare × 0.014 = ounces per acre
kilograms per hectare × 0.89 = pounds per acre
tonnes per hectare × 0.45 = tons per acre

Imperial or U.S. to Metric (Approximate)

Imp. gallons per acre × 11.23 = litres per hectare (L/ha)
U.S. gallons per acre × 9.35 litres per hectare (L/ha)
Imp. quarts per acre × 2.8 = litres per hectare (L/ha)
U.S. quarts per acre × 2.34 litres per hectare (L/ha)
Imp. pints per acre × 1.4 = litres per hectare (L/ha)
U.S. pints per acre × 1.17 litres per hectare (L/ha)
Imp. fluid ounces per acre × 70 = millilitres per hectare (mL/ha)
U.S. fluid ounces per acre × 73 millilitres per hectare (mL/ha)
tons per acre × 2.24 = tonnes per hectare (t/ha)
pounds per acre × 1.12 = kilograms per hectare (kg/ha)
pounds per acre × 0.45 = kilograms per acre (kg/acre)
ounces per acre × 70 = grams per hectare (g/ha)

Liquid Equivalents

Litres/Hectare		**Approximate Gallons/Acre**	
		Imperial Gallons	US Gallons
50	=	4.45	5.35
100	=	8.9	10.7
150	=	13.53	16.05
200	=	17.8	21.4
250	=	22.25	26.75
300	=	26.7	32.1

Application rate conversions (cont'd)

Dry Weight Equivalents

Grams/Hectare		Ounces/Acre
100	=	1 1/2
200	=	3
300	=	4 1/4
500	=	7
700	=	10

Kilograms/Hectare		Pounds/Acre
1.10	=	1
1.50	=	1 1/4
2.00	=	1 3/4
2.50	=	2 1/4
3.25	=	3
4.00	=	3 1/2
5.00	=	4 1/2
6.00	=	5 1/4
7.50	=	6 3/4
9.00	=	8
11.00	=	10
13.00	=	11 1/2
15.0	=	13 1/2

Handy Metric Conversion Factor

Litres per hectare × 0.4 = litres per acre

Kilograms per hectare × 0.4 = kilograms per acre

Conversion tables – metric to imperial

Length

1 millimetre (mm) = 0.04 inch

1 centimetre (cm) = 0.4 inch

1 metre (m) = 39.4 inches

1 metre (m) = 3.28 feet

1 metre (m) = 1.09 yards

1 kilometre (km) = 0.62 mile

Area

1 square centimetre (cm^2) = 0.16 square inch

1 square metre (m^2) = 10.77 square feet

1 square metre (m^2) = 1.2 square yards

1 square kilometre (km^2) = 0.39 square mile

1 hectare (ha) = 107,636 square feet

1 hectare (ha) = 2.5 acres

Volume (dry)

1 cubic centimetre (cm^3) = 0.061 cubic inch

1 cubic metre (m^3) = 1.31 cubic yards

1 cubic metre (m^3) = 35.31 cubic feet

1,000 cubic metres (m^3) = 0.81 acre-foot

1 hectolitre (hL) = 2.8 bushels

Volume (liquid)

1 millilitre (mL) = 0.035 fluid ounce (Imp.)

1 litre (L) = 1.76 pints (Imp.)

1 litre (L) = 0.88 quart (Imp.)

1 litre (L) = 0.22 gallon (Imp.)

1 litre (L) = 0.26 gallon (U.S.)

Weight

1 gram (g) = 0.035 ounce

1 kilogram (kg) = 2.21 pounds

1 tonne (t) = 1.1 short tons

1 tonne (t) = 2,205 pounds

Pressure

1 kilopascal (kPa) = 0.15 pounds/in^2

Speed

1 metre per second = 3.28 feet per second

1 metre per second = 2.24 miles per hour

1 kilometre per hour = 0.62 mile per hour

Temperature

$°F = (°C \times 9/5) + 32$

Conversion tables – imperial to metric

Length

1 inch = 2.54 cm

1 foot = 0.3 m

1 yard = 0.91 m

1 mile = 1.61 km

Area

1 square foot = 0.09 m^2

1 square yard = 0.84 m^2

1 acre = 0.4 ha

Volume (dry)

1 cubic yard = 0.76 m^3

1 bushel = 36.37 L

Volume (liquid)

1 fluid ounce (Imp.) = 28.41 mL

1 pint (Imp.) = 0.57 L

1 gallon (Imp.) = 4.55 L

1 gallon (U.S.) = 3.79 L

Weight

1 ounce = 28.35 g

1 pound = 453.6 g

1 ton = 0.91 tonne

Pressure

1 pound per square inch = 6.90 kPa

Temperature

°C = (°F – 32) × 5/9

Abbreviations

% = percent (by weight)

ai = active ingredient

cm = centimetre

cm^2 = square centimetre

e.g. = for example

g = gram

ha = hectare

kg = kilogram

km/h = kilometres per hour

kPa = kilopascal

L = litre

m = metre

m/s = metres per second

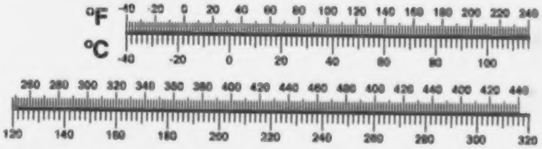
m^2 = square metre

mL = millilitre

mm = millimetre

t = tonne

TEMPERATURE


°F
-40 -20 0 20 40 60 80 100 120 140 160 180 200 220 240
°C
-40 -20 0 20 40 60 80 100
260 280 300 320 340 360 380 400 420 440 460
120 140 160 180 200 220 240 260 280 300 320

For exact values the formula is:

Fahrenheit to Celsius: subtract 32 from number of °F, then multiply by $^5/_9$.

Celsius to Fahrenheit multiply °C by $^9/_5$ then add 32.

Spraying Record

Crop or field no.	Date	Material used	Rate or amount	Weather and soil conditions

Spraying Record

Crop or field no.	**Date**	**Material used**	**Rate or amount**	**Weather and soil conditions**

Emergency and First-Aid Procedures for Pesticide Poisoning

For a major spill, a theft or a fire involving a pesticide, call the Ministry of the Environment at **1-800-268-6060.**

For pesticide poisonings and pesticide injuries, call the Poison Information Centre:

Toronto 1-800-268-9017
1-877-750-2233 (TTY)

PREVENT ACCIDENTS

- **Read the label.** Follow all the precautions the label recommends. Read the First Aid section of the label BEFORE you begin to handle any pesticide.
- **Make sure that someone knows** what pesticides you are working with and where you are.
- **Keep a file of labels and product Material Safety Data Sheets (MSDS) for the pesticides you use.** Make sure everyone knows where to find this in case of an emergency.
- **Post emergency numbers near all telephones.**
- **Keep clean water, paper towels, extra gloves and clean coveralls close by** in case you spill pesticide on yourself.

If someone has been working with pesticides and you see any possible symptoms of pesticide poisoning or injury, take emergency action immediately.

IF AN ACCIDENT OR POISONING HAPPENS

- Protect yourself from injury first.
- Stop the exposure to the pesticide. Move the victim away from the contaminated area.
- Check the four basic facts — identify the pesticide, the quantity, the route of entry and time of exposure.
- Call an ambulance or the Poison Information Centre.
- Start first aid. This is not a substitute for professional medical help.
- **Provide the label, MSDS sheet or container to emergency personnel** at the scene — or take it with you to the hospital. Do not transport pesticide containers in the passenger compartment of the vehicle.

FIRST AID

If a pesticide comes in contact with skin:

- remove all contaminated clothing; wash skin thoroughly with lots of soap and warm water
- dry skin well and cover with clean clothing or other clean material.

If pesticide comes in contact with eyes:

- hold eyelids open; wash the eyes with clean running water for 15 minutes or more.

If pesticide was inhaled:

- move the victim to fresh air and loosen tight clothing
- give artificial respiration if the victim is not breathing.

Do not breathe in the exhaled air from the victim — you could also be poisoned.

If a pesticide was swallowed:

- **call the Poison Information Centre IMMEDIATELY.**

Emergency numbers are listed at the front of each Bell telephone directory.

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- by phone through the ServiceOntario Contact Centre, Monday to Friday, 8:30 AM to 5:00 PM ET
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  - 1-800-668-9938, toll-free across Canada
  - 1-800-268-7095 (TTY), toll-free across Ontario
- in person at ServiceOntario Centres across Ontario

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